Maternal and Child Health Journal (2019) 23 (Suppl 1):S79–S85
https://doi.org/10.1007/s10995-018-02730-z

Driving Policy Change to Improve Micronutrient Status in Women of Reproductive Age and Children in Southeast Asia: The SMILING Project

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Published online: 1 February 2019

Abstract
Objective The SMILING (*Sustainable Micronutrient Interventions to Control Deficiencies and Improve Nutritional Status and General Health in Asia*) project aimed at creating awareness and improving policies around micronutrient deficiencies in five Southeast Asian countries (Vietnam, Laos, Thailand, Cambodia and Indonesia). *Results* The project showed large gaps in recent data on micronutrient status in most of the five countries. By updating existing, or creating national food composition tables, the SMILING project enabled analyses of food consumption in women of reproductive age and young children. Linear programming showed a high risk for multiple micronutrient deficiencies in these groups, and especially in pregnant women. Most programs to improve micronutrient status target iodine, iron and vitamin A deficiency. However, the high prevalence of zinc, vitamin D, thiamine and folate deficiency in the region warrant interventions too. For certain micronutrients (zinc, iron, calcium), dietary changes alone appeared not enough to fulfill requirements. Food fortification was identified to be a sustainable, long-term solution to improve micronutrient intake. Multiple criteria mapping by stakeholders in each country resulted in a list of country-specific priority interventions. Surprisingly, food fortification was ranked low, due to concerns on quality control and organoleptic changes of the fortified food. More advocacy is needed for new, innovative interventions such as delayed cord clamping. *Conclusions for practice* The SMILING project recommends regular surveys to monitor micronutrient status of population, to measure impact of interventions and to guide nutrition policies.

Keywords Micronutrient deficiencies · Policy · Women · Young children · South-east Asia

Significance

Since the 1990, a global fight against micronutrient deficiencies has been conducted, but successes are mitigated. Bringing together multi-disciplinary researchers from different South and North institutions, and stakeholders and policy makers from five Southeast Asian countries, allowed SMILING to recommend sustainable actions to drive policy change to improve micronutrient status in women of reproductive age and children in Southeast Asia. Recommended actions included accurate, representative and regularly updated data on micronutrient status, creation of national coordinating alliances to bring together all stakeholders to collect comprehensive information needed to build consensus on actions needed, and a road map for actions to be implemented at national or specific levels.

Introduction

Micronutrient deficiencies affect billions of people worldwide and prevent at least a third of the world's children from reaching their intellectual and physical potential (MI/UNICEF 2004; Victora et al. 2008). Because of their enormous potential impact on health and human and economic development, the World Bank, UNICEF, and the World Health Organization (WHO) rank micronutrient interventions among the most urgently needed and cost-effective interventions (World Bank 1993). Moreover, the 2012 Copenhagen Consensus Expert Panel concluded that

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combating hunger and malnutrition, especially among young children and women, should be given highest priority (Copenhagen Consensus Centre 2012). Preventing hunger and malnutrition has also a direct impact on sustainable development goals (SDG) 2 and 3 and the Global Nutrition Report 2017 stated that "ending malnutrition in all its forms will catalyze improved outcomes across the SDG" (Development Initiatives 2017).

Recognizing the urgent need for policy change to improve current strategies addressing micronutrient deficiencies in children and women of reproductive age in South-east Asia, the European Union, under the FP7 framework, called for projects addressing this issue. Consequently, the "*Sustainable Micronutrient Interventions to Control Deficiencies and Improve Nutritional Status and General Health in Asia*" project (SMILING) was developed with the main objective to identify priority interventions in selected Southeast Asian countries to improve micronutrient status on a large scale, and to develop a road map for decision makers and donors for inclusion of these priority interventions into their national policies (Berger et al. 2013).

Methodology

The SMILING project was a transnational collaboration of research institutions and implementation agencies in five Southeast Asian countries—Cambodia, Indonesia, Laos PDR, Thailand, and Vietnam—with academic European partners from France, Denmark, UK and The Netherlands. These Southeast Asian countries were chosen as they presented a wide range of social and economic development, as well as different magnitudes and severities of malnutrition, including not only undernutrition and micronutrient deficiencies but also overweight and obesity. The SMILING project promoted a collaborative approach that brought together multidisciplinary specialists from South and North partners to support countries struggling with the complex problems related to micronutrient malnutrition.

The SMILING project was built on three main components, which were executed over the 2 years of the project. The first component, the "information stage" consisted in data collection and the analysis and quantification of the extent of micronutrient deficiencies as a public nutrition problem in Southeast Asia. At the same time, we collected data on current policy and intervention programs in each Southeast Asian country. The second component "the strategy stage" related to consensus building. This included using tools to generate strategic and practical information linking scientific knowledge to implementation, conveying the information to both professional and lay audiences. This included also specifying priority interventions and time frames and mobilizing coalitions and developing means to foster needed changes, and publicizing these elements. The last component "action programming" involved the presentation and advocacy of the list of interventions selected by the SEA countries among policymakers and stakeholders with the challenge to convince policymakers to integrate these interventions into national programs and to plan their implementation in the near future.

State of the Art of Impact of Interventions on Micronutrient Status of Children Under 5 Years and Women in Reproductive Age

The first step was to carry out a state-of-the-art review of the literature on micronutrient needs and research studies, including both pilot studies as well as evaluation of large programs already implemented, carried out globally, or more at regional level, focusing on South Asia and Southeast Asia.

Results have been presented in detail in the first two papers of this issue. The first paper was a review of systematic reviews and focused on anemia and vitamin A, iron and zinc deficiency in children 0–5 years (Campos Ponce et al. 2018). No systematic reviews on folate, vitamin B-12 or iodine outcomes met the inclusion criteria defined by authors. Overall, daily or weekly iron supplementation as well as iron food fortification reduced the risk of anemia while daily iron supplementation was the most efficient intervention in improving iron status. Zinc supplementation but not fortification was associated with increased serum zinc concentrations. High dose vitamin A supplementation increases serum vitamin A concentrations only for a very short period, but does not reduce the risk of vitamin A deficiency in infants and young children. Vitamin A supplementation showed a positive impact on anemia prevalence. When multi-micronutrient (MM) supplementation or fortification is in concern, vitamin A status is improved by supplementation but less so by food fortification. Similar results were found for iron and anemia prevalence while MM fortification has more controversial effects on iron status even if hemoglobin concentrations and anemia prevalence are more consistently improved. Other interventions can also have a positive impact on micronutrient status in children, especially on iron and anemia, such as anthelmintic treatment or malaria treatment when appropriate, and delayed cord clamping. Impact of micronutrient supplementation or fortification on anthropometry and growth are not consistent and failed to reach a consensus due in part to missing appropriated studies even if association of micronutrients, especially zinc, when provided with macronutrients could benefit the growth of infants and young children.

The review of literature carried out by Dijkhuizen and colleagues (2018) evaluates a wide overview of strategies with the goal to formulate appropriate recommendations for national policies to improve micronutrient status and health

for women of reproductive age. Health of women of reproductive age, rather than pregnant and lactating women, as taken as focus, as preconception nutritional status is a key determinant of optimal pregnancy and neonatal outcomes. The authors describe a wide range of nutrition-specific and nutrition-sensitive interventions. Most supplementation programs have focused on pregnant women, providing either iron and folic acid, or multiple micronutrients. Multiple micronutrient supplementation during pregnancy appears to increase birthweight more than iron and folic acid alone. For most nutrition-sensitive interventions, such as cash-transfer, data is lacking on impact on pregnancy and birth outcomes. The only clear exception is delayed cord clamping. Delaying clamping the umbilical cord after delivery for 2 min significantly increases iron stores of the neonate, providing essential iron for the first 6 months of life.

Mapping of Micronutrient Deficiencies Among 0.5 Years Old Children and Women in Reproductive Age and Evaluating the Impact of Interventions in the Five SMILING Southeast Asian Countries

In parallel to these reviews, the prevalence of micronutrient deficiencies among young children and women of reproductive age in the selected Southeast Asian countries was mapped (Roos et al. 2018). This mapping was conducted according to a specific protocol, with data covering either national or at least large-scale surveys. Globally, surveys on key general nutritional indicators such as anthropometric measures for young children, expressed as rates of stunting and wasting are available with a frequency of 5 years or less in each country. In contrast, the mapping of data on micronutrient status in young children and women of reproductive age in the region clearly demonstrated the lack of recent, high-quality and comparable data. However, the data available indicated that micronutrient deficiencies are still a serious public health problem. While vitamin A deficiency was highly prevalent two decades ago, changes in lifestyles and supplementation and fortification programs have all led to a much lower prevalence nowadays. However, other nutrients such as zinc and vitamin D remain a concern. Anemia is a persistent problem in the region, but the underlying causes appears to be more complex than to mainly being mediated by iron deficiency (Wieringa et al. 2016).

The evaluation of the micronutrient interventions conducted in the five Southeast Asian countries shows similarities between four of the five countries (Laos, Cambodia, Indonesia and Vietnam) with programs of micronutrient supplementation to children and women such as vitamin A supplementation to children and iron-folic acid tablets to pregnant women, and to some extend to WRA. Thailand, and to a certain extent Indonesia, implement more actions towards fortified food to solve the problem of micronutrient deficiencies.

Food Fortification

During the SMILING project a special meeting on food fortification was organized. Overviews of the current food-based strategies, fortified food products and current laws and enforcement strategies for fortified foods in each SMILING country was given by representatives of these countries. While all countries had mandatory salt fortification (with iodine), mandatory vitamin A fortification of condensed milk exists only in Thailand, while Indonesia has iron and zinc fortification of wheat flour and instant noodles are fortified with multiple micronutrients. Four countries have voluntary fortification of condiments, staples and complementary foods as a public health strategy. In Vietnam fish sauce is fortified with NaFeEDTA, wheat flour with multiple micronutrients and vegetable cooking oil with vitamin A. In Thailand, broken rice fortified with calcium, iron, folate and vitamin B1 is used for making complementary food. In Indonesia, a pilot implementation on oil fortification with vitamin A has been undertaken as well as rice fortification with iron. In Cambodia soy and fish sauces are fortified with iron and at pilot scale, rice is fortified with multiple micronutrients (iron, folic acid, zinc, vitamins A, B1, B2, B6 and B12) and imported palm oil fortified with vitamin A is available. However, the impact of the programs using these fortified food was most often not assessed. During the meeting, an advocacy session with policy-makers and stakeholders implicated in nutrition, food, agriculture and health sectors was held also.

Most of five Southeast countries plan to develop food fortification strategies, but mentioned limiting factors and needs. The main limiting factors were potential organoleptic changes of the fortified products and the selection of the best fortificants in term of stability, bioavailability and price. Monitoring and quality assurance of the fortification were also a big concern and many stakeholders put this point forward as reason to give food fortification a low priority. Concerns were also expressed regarding the marketing of the products, control of voluntary fortification, and the evaluation of coverage, efficacy and efficiency of the fortified products.

As most of five Southeast Asian countries planned to develop food fortification programs, country-specific recommendations and guidelines of food fortification were developed to support the implementation, monitoring and evaluation of impact of food fortification programs. This was done by adapting the general principles and guidelines to the specific situation of each country, taking into account elements such as the target populations (general population or specific groups), food vehicles (rice, oil, condiments),

micronutrient(s) and their quantities to be added, the food companies and the food distribution system of each country, the quality of control systems in place at government and food company levels and the legislation supporting food fortification.

Consequently, the meeting recommended food fortification as an important intervention. But for food fortification to be a realistic choice, there is a need in each of the Southeast Asian countries to advocate the needs and potential benefits of food fortification. Some relevant issues for consideration include: a comprehensive policy on food fortification, making food fortification mandatory, setting a National Food Fortification Board responsible for all fortified foods, involvement and commitment of national industries, establishing monitoring systems for fortified foods (sharing regional experience, competence and practices), and harmonization of laws at ASEAN level for imported fortified products. Finally, impact should be evaluated, for example through regular national micronutrient surveys. Food fortification should be advocated to the current ASEAN committee on food security to support the exchange of knowledge, expertise, and especially laboratory capacity, which is crucial for quality assurance, and building of trust and capacity.

Besides food fortification actions linking nutrition interventions and the development of food systems should be supported (Ruel et al. 2013).

Improving Food Composition Tables is Essential to Carry Out Food Consumption of Target Populations

Parallel to the work described above, data on food consumption among the target populations in the five Southeast Asian countries was collected. But before being able to analyze these data, there was a clear need for improve food consumption tables (FCT's) for the region to allow an adequate evaluation of dietary intake with a focus on micronutrient content. The methodology and results of this research have been described in detail in this special issue (Hulshof et al. 2018) with a specific focus on most frequent foods and diets eaten by the target populations. Through this, SMILING offered a unique opportunity to increase awareness of the participating institutions and ministries in the five Southeast Asian countries on the importance of high-quality, well-documented food composition data. Updated FCT's with a documented Quality Index (QI) were finalized. However, the self-assigned QI demonstrated considerable room for improvement of the nutrient data quality and efforts have to be pursued to secure maintenance and improvement of each countries' FCT, with a special attention to update the nutrient composition of local foods notably in folate, niacin, vitamin B6, B12, and vitamin D contents. This important task requires recognition and investment of national institutions in sustainable capacity development.

Food Based Approaches Might Contribute But Not Ensure Dietary Adequacy for Women and Young Children

Before being able to recommend certain food based approaches, the SMILING project evaluate whether only the promotion of the consumption of locally available, nutritious foods, could ensure dietary adequacy for 11 micronutrients in women of reproductive age and young children (Ferguson et al. 2018). For this purpose, representative dietary data from the five Southeast Asian countries were analyzed using linear programming analyses to identify "problem nutrients" i.e. nutrients that are likely to have an intake that is too, and to formulate food-based recommendations (FBRs) per country.

The number of problem nutrients ranged from zero for 12–23 months old in three countries, to six out of eleven for pregnant women in Cambodia. In all Southeast Asian countries except Lao PDR, women of reproductive age, and especially pregnant women, tended to have a higher number of problem nutrients than children. The most common problem nutrients across all countries and target populations were calcium and iron, and also zinc in children. For women, folate and riboflavin were common problem nutrients. Only vitamin C and vitamin B12 were not regarded as problem nutrients for any target population.

After analyzing the food patterns of the nutritionally best diets by country, different combinations of foods were assessed in their capacity to ensure dietary adequacy. For children, iron, zinc and calcium were the nutrient requirements that were the most difficult to achieve using local foods, followed by thiamine and niacin. For women folate "replaced" zinc in the list. Lao PDR showed a special situation where thiamine and vitamin B6 would be the most difficult nutrients.

Using this modeling, food-based recommendations hypothetically were proposed for each target population that would ensure dietary adequacy at the population level. For all target populations, the sets of FBRs included meat, fish and/or eggs and vegetables, especially green leafy ones. Fruits were included for all target populations except for children in Cambodia. Other FBRs were legumes/soy, dairy products, liver or organ meats, pork and eggs.

Action Programming for Contribution to National Nutrition and Health Policies

The last stage of the SMILING project was to analyze how national stakeholders would support the introduction and implementation of strategies to prevent micronutrient

deficiencies at national level. A large range of stakeholders concerned by combating malnutrition was reached to participate to this consultation in order to capture the perception of strategies: from the government to the civil society including private sector, academics, United Nations organizations, funders and international NGO. While each country and each stakeholder interviewed was free to propose any intervention for evaluation, we tried to harmonize categories of intervention in order to give a comparable overview of stakeholders' perception over countries. Five categories of strategies were finally defined and appraised: supplementation, fortification, food-based approaches, educational and research initiatives and sensitive interventions. Each category of strategies could have gathered both "innovative" or "classical" types of intervention. The selection of the criteria to appraise the intervention was by itself informative of the priority given in the choice of strategies to combat micronutrients deficiencies. Feasibility, impact, effectiveness, sustainability and availability of resources were the criteria most often chosen by the stakeholders to appraise strategies. Only three countries considered acceptability of a strategy as a criterion to evaluate its potential.

One of the main finding was that, whatever the country and the nutritional situation, stakeholders generally ranked higher the interventions that have already been implemented and are well documented and supported rather than more innovative strategies. Direct or therapeutic interventions were consistently preferred over the indirect interventions. For example, food fortification strategies were ranked low by all countries except Indonesia despite SMILING country experts regarded these strategies as effective. The implementation of innovative strategies appeared to be mainly impeded by the lack of awareness on scientific evidence of impact, the lack of technical support and the lack of distribution channels or the complexity to reach specific population such like WRA. This finding calls for more efforts to build up and disseminate the scientific evidences of impact of strategies and to develop the technical supports for implementation and monitoring of efficient strategies.

Lessons Learned from the SMILING Project and Perspectives

First of all, SMILING was a human and participative adventure. The SMILING project has been conceived since its conception around a strong North-South-South collaborative approach allowing creating a regional platform with a critical mass of Southeast Asian and European scientists, with different backgrounds, competence and functions that enriched the discussion and exchanges. SMILING forged the spirit of working together across institutions from developing and developed countries to create value. Beyond achievement of effective scaled-up interventions to improve nutritional status of women and children, capacity building in the Southeast Asian countries was paramount, including training of young researchers and dissemination of new methodological tools.

The societal dimension of the project was contained in its objective as action was directed towards the well-being and health of the most vulnerable populations in the context of poverty and transition. SMILING placed young children, adolescent girls and women of childbearing age in the center of the action and as privileged beneficiaries of interventions. SMILING produced knowledge and tools, linking science and society that allowed stakeholders to judge the efficiency and potential risks of interventions (including the risks associated with a lack of action) and guide their implementation.

The dissemination plan of SMILING was to share the progress of the project with a large audience and allow external contributions to the project, to disseminate the project outcomes to the main stakeholders in the target countries, and to national, regional and international audience.

In most of the five Southeast Asian countries, few accurate data were available, except for anemia prevalence. But it is essential that governments get regular updated, reliable and representative data on micronutrient status of the population, to allow not only accurate evaluation of the impact of programs, but also to monitor nutritional changes in the population, to guide nutrition-related policies and avoiding inappropriate actions. Therefore, SMILING consortium recommends that each country establishes a representative database of nutritional status, which must integrate not only data on undernutrition, overweight and obesity, but also on anemia and micronutrient deficiencies, taking into account that sub-national pockets may show particularities. For micronutrients, it is recommended to include the evaluation of the population's status of several key vitamins and minerals (zinc, B-vitamins, Vitamin D and calcium) in addition to the evaluation of iron, iodine and vitamin A. Linking national micronutrient surveys with existing regular national surveys, such as the Demographic Health Surveys would be an excellent investment.

SMILING allowed the Southeast Asian countries and beneficiaries to integrate new tools such as the mathematical linear modelling and the Multi-Criteria-Mapping, and to update their knowledge and practices in creating and/or updating the food composition tables, and in planning and implementing food fortification programs. Consequently, a real capacity and competence was developed in each Southeast Asian country with the advantage of the harmonization of tools at regional levels allowing comparisons, exchanges, collaborations. The findings generated by these tools allowed translation of knowledge to policies and programs for alleviating micronutrient deficiencies. These tools are expected to have future application for other nutrition related issues, and

the capacity built can be mobilized to benefit other countries in the region.

The mathematical linear programming technique strongly suggests that diets of the target populations in the five Southeast Asian countries were deficient in several micronutrients, even in the best-diet options. Therefore, integrated and complementary nutritional strategies, both specific and sensitive, have to be implemented. For a long-term success and sustainability, a food-based strategy for improving micronutrient intakes of children and women must be enhanced, either as multi-micronutrient fortification of e.g. complementary foods, or a combination of improving diets (dietary diversity or enhanced intake of animal-source foods) and multi-micronutrient fortified foods.

Setting up complementary interventions requires a multisectorial commitment of key actors and stakeholders. The country-specific list of interventions generated different priorities varying widely across countries and between stakeholders in the same country. The level of information of stakeholders about nutrition and the potential of the different interventions to solve malnutrition were keys elements in advocating for investment in nutrition. The SMILING consortium recommends creating in each country a national platform (nutrition coordinating alliance) that brings together all the stakeholders to receive, share and integrate comprehensive information needed to build consensus on the actions to be implemented at national level. Micronutrient strategies will be taken into account by policymakers, when proposed interventions (both nutrition specific or sensitive) will be easily accessible and presented in a form understandable by all. For instance, food fortification that was highly supported by the beneficiaries from the five Southeast Asian countries, was ranked low in priority by the stakeholders in all countries except Indonesia, especially in comparison with supplementation, mostly because of concerns and uncertainties that underline the need for appropriate communication to allow informed decision. Also, innovative interventions such as weekly supplementation for women in reproductive age were not well supported although there is growing scientific evidence of its efficacy and effectiveness in Southeast Asia (Cavalli-Sforza et al. 2005; Viteri and Berger 2005). Therefore, International Organizations (WHO/UNICEF/WFP) have their role to inform, advocate and to provide technical assistance.

Finally, the SMILING consortium agreed that action to improve micronutrient status of vulnerable groups should follow a holistic approach and has to be country-specific. Country-tailored packages of interventions are needed, taking into account the underlying micronutrient deficiencies and cultural aspects, for intervention to be accepted within the country or within specific regions. And only by addressing the double (or triple) burden of malnutrition, giving special attention to adolescent girls, women of reproductive age, infants and young children, can real progress being made.

Funding The SMILING project was funded by the European Commission in the 7th Framework Programme for Research and Technological Development (GA 2896 16).

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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