Improving maternal and child nutrition in China: An analysis of nutrition policies and programs initiated during the 2000-2015 Millennium Development Goals era, and implications for achieving the Sustainable Development Goals

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Abstract

Background: Although good progress was made in maternal and child nutrition during the Millennium Development Goals (MDGs) era, malnutrition remains one of the major threats on global health. Therefore, the United Nation set several nutrition-related goals in the Sustainable Development Goals (SDGs). There is much to be learned from individual countries in terms of efforts and actions taken to reduce malnutrition in order to achieve the nutrition-related SDGs. China as a developing country launched a number of nutrition improvement policies and programs, that resulted in dramatic progress in improving maternal and child nutrition during the MDGs era. This study explored the impact, experiences and lessons learned from nutrition policies and programs initiated in China during the MDGs era, and implications to achieve the SDGs for China and other developing countries.

Method: The CNKI database and official websites of Chinese Government were searched for reviews on nutrition-related policies and intervention programs. A qualitative study was conducted among key informants from the Chinese government, Non-governmental Organizations (NGOs) and Universities for two major national nutrition intervention programs.

Results: The literature review documented that during the MDGs six nutrition policies and eight trans-province and nationwide nutrition intervention programs collectively made good progress in improving maternal and child nutrition in China. Nutrition Policies tended to be targeted at infants and children, with less attention on reproductive and maternal nutrition. Nutrition intervention programs focused primarily on undernutrition and achieved positive results, while for breastfeeding
improvement and prevention and control on overweight and obesity were limited. Results from the qualitative study indicated that effective nutrition program implementation was facilitated through cooperation of multiple sectors and by government and NGOs partnerships, however, still face challenges of insufficient local working funds, monitoring and inadequate management.

Conclusion: Nutrition policies and intervention programs promulgated in China during the MDGs era made major contributions to the rapid decline of undernutrition, and are in line to achieve the SDGs related to child wasting, stunting, low birth weight and anemia in reproductive-age women. However, policies and program implementation are needed to improve exclusive breastfeeding rates and reduce obesity to achieve the SDGs.

Background

The Millennium Development Goals (MDGs), established by the United Nations (UN) in 2000, set out eight ambitious goals to be achieved by 2015. Two of them were directly linked to the health of children and women: 1) Reduce by two thirds the mortality rate among children under five; 2) Reduce by three quarters the maternal mortality ratio. During the MDGs era, maternal and child nutrition has been improved greatly in many developing countries through various intervention and policy strategies. The Global Nutrition Policy Review (2013) based on 119 World Health Organization (WHO) Member States indicated that most countries had a range of policies and regulations on nutrition[1], including breastfeeding and complementary feeding improvement strategies, micronutrient supplements for pregnant women, infants and young children[2], school feeding programs[3] and
child obesity interventions\cite{4}. These interventions played an important role in improving child and maternal nutrition in many developing countries. Counseling or educational interventions increased exclusive breastfeeding (EBF) rates\cite{5}, supplementation with folate and iron reduced the risk of anemia and maternal death\cite{6, 7}, providing micronutrient supplementation to pregnant women reduced the risk of low birthweight\cite{2}, school feeding programs reduced the rate of stunting, wasting and anemia\cite{3} and also increased cognitive and learning ability\cite{8}, school-based obesity interventions \cite{4}, nutrition and agricultural policies\cite{9} and food labeling\cite{10} reduced the incidence of child obesity.

While good progress was made in maternal and child nutrition during the MDGs era, malnutrition remains one of the major threats on global health. According to the WHO, in 2016 an estimated 155 million children under the age of 5 were suffering from stunting, while 41 million were overweight or obese; roughly 45% of deaths among children under 5 years of age were linked to undernutrition\cite{11}. Every country in the world is affected by malnutrition. WHO indicates\cite{11} combating malnutrition in all its forms is one of the greatest global health challenges, diverse multi-sector interventions aimed at changing behaviors at the individual level combined with policies, systems and environmental changes need to be considered for implementation at a national scale to eliminate malnutrition. There is much to be learned from individual countries in terms of efforts and actions taken to reduce child malnutrition, in order to achieve the nutrition-related 2030 Sustainable Development Goals (SGDs)\cite{12-13}.

China as a developing country launched a number of nutrition improvement policies
and programs, that resulted in dramatic progress and impact in improving maternal and child nutrition during the MDGs period from 2000–2015. For example, in China from 2002 to 2013 for children under 6 years the rates of stunting were reduced in half from 16.3–8.1%, wasting was reduced from 2.6–2.0% and underweight from 5.7–2.5%. Anemia rates for pregnant women decreased from 28.9–9.3% and among lactating mothers from 30.7–17.2% [14].

Policy and program analysis enable us to better understand and strengthen the policy environment and intervention programs [15]. Interviews with stakeholders involved in developing and implementing nutrition intervention programs are important to better understand programs successes, challenges and improvements needed in China achieve the nutrition-related SDGs [12–13].

For this study, reviews of literature and policy documents evaluating nutrition-related policies and intervention programs in China during the MDGs (2000–2015) were conducted, and qualitative interviews were conducted with key informants from the Chinese government, non-governmental organizations (NGOs), and Universities for two major national nutrition programs. The aim of the study was to better understand the experiences and best practices in China regarding the nutrition-related MDGs, in order to achieve the 2030 nutrition-related SDGs [12–13]. Further, the experiences and lessons learned from China have implications for other developing countries facing similar nutrition and health problems that China faced two decades ago, and could provide insights into improving maternal and child nutrition to achieve the nutrition-related SDGs [12–13].

Methods
**Review of literature and policy documents**

This study utilized the China National Knowledge Infrastructure database (CNKI) to search and collect the studies and documents on nutrition policies and interventions programs for Chinese women and children from January, 2000 to December, 2015. Studies were searched using the following terms: maternal nutrition, infant nutrition, child nutrition, nutrition policies and intervention programs. We also checked references of included studies and documents in order to collect more information. Searches were also conducted of official websites of the Chinese government and related departments (e.g., Ministry of Education (MoE) of China[1], National Health and Family Planning Commission of China (HFPC)[2], United Nations International Children's Fund (UNICEF)[3]). In addition, grey documents were included in our study, and we also consulted with related experts and institutions for more detailed information about the nutrition policies and intervention programs for Chinese women and children.

**Qualitative interviews**

Qualitative interviews with key informants knowledgeable on the maternal and child nutrition intervention programs during the MDGs period (2000-2015) were conducted at the national and provincial levels during June and July, 2017.

**Sampling and Participants**

Purposive sampling, as well as snowball sampling were used to select the key informants. Consultants and Steering Committee members from the Gates funded grant “Achieving Health-Related SDGs in China: Developing Evidence-based Options for Actions” (Principal Investigator Dr. S.T) helped with the selection of key
informants. To better understand the implementation of nutrition policies and programs across the mainland of China, interviews with key stakeholders from both the national level and provincial level (Hubei and Yunnan, representing average and less developed regions of China respectively) were conducted.

A total of 23 key informants participated in the interviews with 10 stakeholders from national sectors, 6 at the provincial sector levels from Hubei and 7 from Yunnan. These informants had experience and expertise in maternal and child nutrition, and included the chief leader from Chinese Centers for Disease Control and Prevention (CDCs), HFPC, MoE, maternal and child hospitals, national foundations (e.g. China Children and Teenager’s Fund (CCTF), China Development Research Foundation (CDRF)), All-China Women's Federation (ACWF) and UNICEF, and nutrition intervention programs and experts from the top universities/institutions in China (see appendix table S1).

**Interview methods**

The interviews followed a semi-structured topic interview guide conducted in Chinese. The topic guide was formulated based on the literature reviews of intervention programs and consultation from nutrition experts, which was then adjusted according to the specialties of the interviewees, in order to obtain as much detailed information as possible. The interview guide mainly included three themes of each nutrition intervention program: 1) Enabling factors; 2) Implementation challenges; and 3) Stakeholders’ views on sustainability. To ensure the authenticity and effectiveness of the interview, researchers contacted the interviewees in advance, providing information on the context of the interview and interview
questions that would be asked during the interview.

The in-depth interviews were conducted in-person by a Chinese researcher (one of the co-authors). All interviews were recorded anonymously with informed consent. Each interview lasted about 45-60 minutes. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethics Committee of Duke University (2017-1359)

**Data analysis**

**Literature/policy document review and analysis.** We systematically summarized for each article/report: the maternal and child nutrition-related policy or policies (issued department, duration of implementation, target population, nutrition-related content) and intervention programs (target population, implementation area and duration, organizer, contents and effects) in China.

- **Qualitative data analysis.** All the analysis stages were conducted independently by two researchers. A six-stage Framework Approach[^16^] was used to guide the qualitative analysis: 1)Transcription: all audio-taped interviews were transcribed verbatim by one researcher and kept anonymous, and checked by another researcher; 2) Familiarization: all interviews were read in full text by 2 independent researchers simultaneously. Notes were made in the interview transcriptions if any important segments were identified; 3) Development of an analytical framework: thematic framework was developed based on the objectives, topic guide and new themes from the interviewees; 4) Coding: MAXQDA (version 12) was used to manage
transcriptions. Coding was performed by two researchers, one responsible for coding, and the other responsible for checking; 5) Charting: a case display was formulated per interview (participant) based on thematic framework. Each case consisted of a short interview answer of each question; 6) Interpretation: summarize the main findings and present the results with key quotations in the text.

[1] Ministry of Education of the People’s Republic of China. http://www.moe.gov.cn
[2] National Health and Family Planning Commission of the People’s Republic of China. http://www.nhc.gov.cn
[3] United Nations International Children's Fund. https://www.unicef.org

Results

**Overview of nutrition intervention policies during the MDGs (2000-2015)**

The results of the literature review, documented that during the MDGs, the Chinese government enacted several national nutrition policies to improve maternal and child nutrition; and six policies showed the most impact (table 1). Of those, three were issued by State Council, two by MoH, and one by MoE. Four of the six focused on children under 5 years of age and school-aged youth; One was aimed at women (the *Outline for the Development of Chinese woman*); and one the *Outline for the Development of food and nutrition* was for all Chinese residents, with emphasis on priority populations (e.g., infants and children, adolescents, women, and the elderly). For nutrition areas, two of the policies focused on undernutrition improvement of woman or school-age children without specific goals; the *Outline for the Development of Chinese Children, Infant feeding strategy* and *Technical specification and guidance on child feeding* addressed the child undernutrition
including low birth weight, stunting, anemia, micronutrient deficiency and breastfeeding or complementary feeding, two of them had specific nutrition goals. The *Outline for the Development of Food and Nutrition in China* is the most comprehensive nutrition policy, which focused on improvement for undernutrition and infant feeding, but also took overweight and obesity into account. Priority was given to geographic regions (e.g., rural and western areas), and the food industry (e.g., dairy industry, soybean industry and food processing).

**Overview of the nutrition intervention programs during the MDGs era**

Findings from the literature review indicated that during the MDGs period, eight trans-province and national maternal and (or) child nutrition intervention programs were implemented. Most of these programs were organized by multiple government sectors, and NGOs such as ACWF, UNICEF. Six of the programs aimed to improve child undernutrition, including wasting, stunting, underweight, micronutrient deficiency and anemia. Among them, two focused on both maternal and child health, two were targeted at infants under 3 years, and two programs to benefit primary and middle school students. The other two programs focused on breastfeeding promotion and child obesity interventions. Table 2 summarizes the target population, implementation area, content and intervention impact of these programs.

**Qualitative analysis on selected nutrition programs**

Of the eight nutrition intervention programs, the *Nutrition Package for 6-24 months Infants Program* (*Nutrition Package Program*) and the *Nutrition Improvement Program for Rural Compulsory Education Students* (*Nutrition Improvement Program*)
(Table 2) were the two most extensively implemented, as well as effective nutrition interventions in China and played an essential role in the improvement of child nutrition. Based on the qualitative interviews, we analysed the enabling factors, challenges and stakeholders’ views on sustainable development of the two programs.

**The Nutrition Package for 6-24 months Infants Program**

**Enabling factors**

According to the respondents, the successful implementation of the nutrition package program for 6-24-month-old was attributed largely to: 1) the efficient execution of a three-tiered network consisting of a county-township-village system, 2) cooperation between government departments and social organizations, and 3) support from national policies and funding.

- **County-township-village system:** “The implementation of the program is in the village, through the village doctor a maternal and child health care system. The county-township-village system is helpful”. (Vice director of Children sectio CDRF)

- **Cooperation of government sectors and social organizations:** “MoH not only issued documents and notices to stipulate tendering and procurement requirements, but also hold an annual experience meeting for the promotion of nutrition improvement projects”. (Director of Child Health Sector of Maternal and Child Health Department, MoH)

- **Support from national policies and funding:** “National finance allocated 100 million financial support for the purchase nutrition packages and training of nutrition knowledge, while many enterprises provide financial support for the promote nutrition packages.” (Director of Child Health Sector of Maternal and Child Health Department, MoH)

**Implementing challenges**

The qualitative analysis found four major challenges: 1) the “low price” bidding principle that local governments are required to choose the third party company with the lowest bid to make the nutrition package, 2) funding shortages of local government, 3) improper storage of nutritional packages, 4) migrant children receive limited nutrition packages due to large population mobility
The “low price” bidding principle: “Many companies bid to make nutritional packages, the principle that local governments must choose the company with the lowest bid causing price competition, which reduced the quality of nutrition packages”. (Vice director of Children section, CDRF)

Funding shortages of local government: “The funds for the staff of villages doctor and personnel training for which local budget paid in this project is insufficient, as the local government is too poor to afford that.” (Vice Director of Child health department, Maternal and child hospital in Yunnan province)

Improper storage of nutritional packages: “There is a batch of nutrition packs stored in hot environments, resulting in fatty acids degradation in Yunnan Province”. (Vice Director of Child health department, Maternal and Child hospital in Yunnan province)

Migrant children: “There is a large number of people migrant from rural to city for working in China. Children who migrated to city with their parents cannot get nutrition packages because the packages were issued according to household registration.” (Vice director of Children section, CDRF)

Stakeholders’ views on sustainable development

In order to achieve sustainability of the programs, key informants from across departments proposed improvements in cost-effectiveness, a larger population reach, and practical strategies.

Central finance supporting for poor local government: “The national budget should arrange a sum of money to support some poor local government for stuff training, publicity, village doctor subsidies, etc.” (officer of Maternal and Child Health Sector, MoH of Yunnan)

Strengthen bidding management: “The bidding for nutrition packages should be controlled more strictly from the scientific and technical level. Apart from the price, the quality of nutrition packages should also be taken into consideration.” (project officer of CCTF)

Strengthen evaluation: “To further implement the project, it is necessary to strengthen the management. The first is to strengthen evaluation of the projects to find and solve the problem and adjust the implementation plan in time.” (professor from School of public health, Wuhan University)

Nutrition Improvement Program for Rural Compulsory Education Students

Enabling factors

Findings from the qualitative interviews indicated three main factors that were effective in promoting the implementation of the nutrition improvement program: 1) active promotion, 2) technical guidance from government and 3) collaboration among several government sectors.

Active promotion: “MoE of Yunnan province have been trying to publicize the regulations and objectives of this project in schools, and some media has also reported the information of the project.” (Director of Financial department, MoE of Yunnan)

Technical guidance from government: “The Chinese CDC has developed an ‘electronic nutritionist’ to guide the school canteen to conduct balanced diet, we (Yunnan government) also commissioned universities to formulate 12 recipes for school based on Yunnan local ingredients.” (Director of Financial department, MoE of Yunnan)

Collaboration between government sectors: “We (Chinese CDC) have been responsible for the comprehensive monitoring and evaluation of the program. We organized 699 counties every year to carry out monitoring and evaluate collected data such as body weight and blood sample of students, and then detect hemoglobin, VA and VD. In addition, participated in the formulation of rules, dietary guidance and nutrition education, organization of provincial nutrition training and preparation of reports.” (Vice director of Student’s Nutrition Office, Nutrition Department of Chinese CDC) “We (MoE were mainly responsible for safety of food and funds to protect students' food safety and prevent corruption and waste (officer of Education supervision bureau, MoE of China)
Challenges in program implementation

Because the project covered a wide geographical area, involved a large number of departments and had no precedent to follow, it has faced several problems: 1) misconceptions from parents, 2) shortage of operational funding, 3) lack of nutrition professionals, and 4) poor monitoring of quality. Additionally, the program has excluded preschool children, and poor students in the urban cities, which caused unfairness and inequities.

Misconceptions from parents: “Some parents simply regarded the program as free lunch, relying solely on government subsidies to feed their children and not taking responsibility for feeding them, which caused ‘crowding-out effects’ in many regions.” (Officer of Education Supervision Bureau, MoE)

Shortage of operational funding: “Same as the ‘nutrition package’ program, the national finances did not allocate services and work expenses, which need to be supported by the local authorities, so that the project monitoring, canteen catering staff, personnel training work is difficult to carry out due to the shortage of local finance. (Director of Financial department, MoE of Yunnan). Lack of implementation funds made it hard to engage staff and monitor the effectiveness” (Director from Department of Physical, Health and Arts, MoE of Hubei)

Lack of nutrition professionals: “The other problem is that children, canteen staff knew very little about nutrition knowledge, making it hard to provide students with a balanced meal.” (Vice director of Student’s Nutrition Office, Nutrition Department of Chinese CDC)

Poor monitoring: “The monitoring sample size is too large, the work fund and manpower cannot meet the needs of monitoring work; monitoring staff lacks regular physical examination and questionnaire survey training, which make it difficult to guarantee the quality of monitoring data.” (Director from Institute of Health Surveillance and Prevention, Hubei CDC)

Unfairness and inequities: “In fact, children in the year before first grade, called preschool, was not covered by the program.” (Director from Nutrition department of Public Health School, Peking University) “The main problem now is fairness. Student participating in the program is based on household registration, only rural students could be included, without account the urban poor students.” (Committee of experts on the Nutrition Improvement Program; professor of School of public health, Kunming Medical University)

Stakeholders’ views on sustainable development

In response to these challenges, informants from various sectors (Nutrition Department of Chinese CDC, UNICEF, CDRF, Hubei CDC, MoE of Hubei and Kunming Medical University) put forward recommendations for sustainability of the project as presented in the following box.
Reconsider the inclusion criteria of target children: “I think the inclusion criteria should be changed, for example include children from urban poor families. Rural household registration should not be used as a standard of entry.” (Committee of experts on the Nutrition Improvement Program; professor of School of public health, Kunming medical university)

Pay attention to child obesity: “At present, undernutrition is not completely solved, while the problem of overweight obesity has emerged. In this case, the project should pay attention to both undernutrition and overweight and obese children.” (Committee of experts on the Nutrition Improvement Program; professor of School of public health, Kunming medical university)

Develop adequate legislation: “I suggest that the government should introduce a law on nutritional protection for students, and establish a sound nutritional feeding system so that the nutrition of students in poor areas could be protected by law” (Director from Department of Physical, Health and Arts, MoE of Hubei)

Enhance the nutrition knowledge and skill of students, teachers, parents and canteen staff: “I think the nutrition and health education of students, teachers and parents, should be strengthened, so that students can cultivate good eating habits.” (Director of Child & adolescent nutrition, UNICEF) “It is very important to train the canteen staff to improve the nutritional knowledge and catering skills.” (Vice director of Student’s Nutrition Office, Nutrition Department of Chinese CDC)

Scientific evaluation: “The indicators for evaluation are relatively singular. The current indicator of height and weight not only related to diet, but also affected by other factors, such as sleep, exercise, hormones and many other factors. So, this monitoring design should be more reasonable.” (Committee of experts on the Nutrition Improvement Program; professor of School of public health, Kunming medical university)

**DISCUSSION**

China made dramatic progress in improving maternal and child nutrition and reducing undernutrition during the MDGs period from 2000 to 2015. This study examined the scientific literature and reports on nutrition policies and programs in China during the MDGs era, and conducted key informant interviews with government and NGO officials and academics to document successes, challenges and lessons learned from the leading national nutrition intervention projects. The aim was to understand the experiences improving maternal and child nutrition in China that could help achieve the nutrition-related 2030 SDGs in China. Lessons learned could also be used by other developing countries facing similar health problems to China to improve maternal and nutrition and achieve the nutrition-related SDGs.

**Implementation of nutrition-related policies**

During the MDGs, China promulgated six nutrition policies and regulations to promote nutrition and health conditions of Chinese woman and children. These nutrition policies not only focused on the nutritional needs of women and children of all ages, but also children at certain ages and economic conditions. For example,
breastfeeding and complementary feeding improvement of infants, and the nutrition of school children from poor rural families. Additionally, the nutritional policies put forward specific nutritional goals to be achieved in certain years, identified and prioritized key areas and populations, as well as relevant technical guidance for nutrition improvement.

While progress was made, we also found a number of shortcomings of nutrition policies. First, the issued policies put most of the focus on undernutrition, complementary feeding and breastfeeding improvement, while goals and guidance for prevention of overweight and obesity was rare. Secondly, currently there are no laws to guarantee the effective implementation of relevant policies throughout provinces, cities and regions in China. For example, the *China Nutrition Improvement Action Plan* issued by the State Council in 1997 has not been implemented widely until 2003[40]. It is not possible to clarify the responsibilities of various departments, and guarantee the cultivation and maintenance of nutrition professionals. In contrast, Japan and the United States have made major breakthroughs in nutrition improvement programs. The US enacted a series of federal nutrition-related laws in the 1960s and 70’s to reduce hunger and to guarantee implementation, such as the *National School Nutrition Lunch Act*[41], and in Japan the *school feeding law, nutrition improvement law* and *Nutritionist Law*[42].

**Experiences of nutrition programs and implications for achieving the Sustainable Development Goals**

China implemented eight nationwide maternal and child nutrition intervention
programs during the MDGs period. Several government sectors and NGOs were involved in developing and implementing each of the programs, for example, MoH, collaborated with MoF for Nutrition Package Program, and MoE, MoF, MoH and CDC worked collaboratively together for the Nutrition Improvement Program. Multi-sectoral collaboration among government sectors including health, finance, education sectors built a comprehensive implementation system for nutrition interventions. The collaboration between health-related NGOs including UNICEF, ACWF, CDRF, WHO, who had international experience and innovative ideas was one of strongest enabling factors for maternal and child nutrition improvement interventions in China. Additionally, we found that China prioritized and focused heavily on improvements to reduce child undernutrition.

For undernutrition, six programs have been launched by the Chinese government and NGOs, achieving positive results. These interventions have reduced the incidence and prevalence of maternal and child undernutrition including anemia, stunting, underweight and neural tube defects (table 2). But more progress needs to be made in undernutrition interventions, for instance, the target population has been mainly infants aged 6-24 months and primary and middle school students, with less attention on preschool children 24-48 months of age. Further, as shown in the qualitative analysis, the two key nutrition interventions in China continue to face challenges of insufficient local working funds, lack of monitoring and inadequate management. For undernutrition, the SDGs set four goals, including by 2025: 1) 40% reduction in children younger than 5 years who are stunted; 2) 50% reduction in prevalence of anemia in reproductive-age women; 3) 30% reduction in annual incidence of low-birth weight; 4) Reduce and maintain childhood wasting to <5%\(^{12,}\)
According to the report of Nutrition and Health Status Surveillance System of Chinese Residents (CNHSS)\[^{14}\], in 2013 the wasting and stunting rate of children under 6 year were 2.0% and 8.1% respectively, and the low birth rate was 3.1%, the rate of lactating women anemia was 9.3% and that of pregnant women was 17.2%. The wasting rate has already reached the SDG target and the low birth rate is on target. For child stunting and anemia in women, policies and intervention programs have achieved positive results (table 2). Therefore, the SDG nutrition targets of child stunting, low birth rate and anemia in women in China could likely be achieved if the challenges mentioned above could be addressed with multi-sector approaches.

For breastfeeding interventions, we found although several policies and guidance for EBF improvement were issued, they have not been implemented well. According to the report of CNHSS, the EBF rate for infants aged 6 months in China in 2013 was only 20.8\[^{14}\], which is far away from the SDG goal of 50\[^{12-13}\]. On one hand, intervention actions on EBF improvement were few. The baby-friendly hospital is the only nationwide intervention program in China. On the other hand, although China started to establish baby-friendly hospitals in 1992, few evaluations have been conducted on its impact. In our literature search, we only found two hospital-based articles evaluating the effects of improved breastfeeding rates \[^{43,44}\] and one survey\[^{45}\] evaluating the comprehensive effect including improvement on EBF and breastfeeding rates, knowledge and neonatal morbidity, and no nationwide evaluations have been done. Sound monitoring and evaluation system has not been established to evaluate the effectiveness of baby-friendly hospitals, which may be
one of the reasons why the EBF rate of infants aged 6 months in China have been low, despite that baby-friendly hospitals have been around for over two decades. More interventions and evaluation on breastfeeding improvement should be initiated in China to achieve the EBF SDG goal.

Regarding overweight and obesity, although China's childhood overweight and obesity rates were already at a high level (the overweight rate for children under 6 years in 2013 was 8.4 % and 3.1% for obesity\(^{[14]}\)), few regulation and targets have been issued to prevent and control obesity, and nationwide intervention programs on prevention or treatment of child obesity are rare. The school-based program “Happy ten minutes” is the only nationwide intervention on child obesity.

Furthermore, this program only targeted at primary students, without obesity intervention actions for children in pre and middle school. The SDGs for child overweight and obesity are no increase in childhood overweight\(^{[12-13]}\). From 2002 to 2013, the rate of overweight and obesity of children under 6 years increased by 1.9% and 0.4% respectively\(^{[14]}\). Therefore, more coordinated national overweight and obesity polices and intervention actions for pre and middle school children are urgently needed in order for China to achieve the SDG goal of no increase in childhood overweight.

**Lessons learned from China for other developing countries**

China's positive experience on reducing undernutrition provides several important lessons for other developing countries with high rates of undernutrition: 1) Achieving rapid reductions in undernutrition clearly requires high-level political attention. The Chinese government has realized the importance of nutrition,
especially for children and women. During the MDGs era a large number of nutrition policies were promulgated, not only at the national level, but also poverty-stricken and rural areas. These nutrition policies are the basis for nutrition work; 2) Policies with priority targets are another reason for the progress and achievement made in China through the nutrition interventions. Prioritized nutrition, especially in poverty and remote areas, the focus on 0-24-month-old children and women is important for improving nutrition. Further more specific nutritional goals and technical guidance for nutrition policy are also essential; 3) Nutrition interventions play an essential role in improving maternal and child nutrition and require multi-sectoral collaboration of related government sectors and NGOs, and a comprehensive monitoring system. The implementation of nutrition intervention in China involves multiple sectors, such as finance, health and education, only by clarifying their respective responsibilities and cooperating with each other can the programs be implemented successfully. The NGOs, such as UNICEF and ACWF are important collaborators in conducting nutrition intervention pilots, disseminating nutrition knowledge and monitoring intervention effects. Governments need to establish public-private partnerships with NGOs. A monitoring system is essential for nutrition interventions, not only to evaluate trends and progress, but also help to identify gaps, problems and any unintended consequences. In addition, the challenges that China is facing, such as lack of local budgets, problems with monitoring systems, lack of a nutrition workforce and large population mobility, may alert other developing countries that when planning and implementation nutrition interventions, more attention needs to be paid to minimize and avoid similar problems.
In this study we reviewed the content of nutrition policies and projects in China during the MDGs, and the experiences, challenges and recommendations for the major national nutrition intervention projects. Nevertheless, several potential limitations should be acknowledged. Although we conducted a comprehensive review of maternal and child nutrition policies implemented during the MDGs era in China, we found the evaluation of policies are insufficient, and therefore we cannot adequately assess effectiveness or impact. Also, we only assessed the effects of nutrition intervention policies on nutrition improvement and evaluation of implementation and cost-effectiveness of the two projects is lacking. Our qualitative interviews were only for project leaders and managers. We did not interview the target populations of those two projects. Still, our findings will be beneficial in informing efforts to achieve the SDG nutrition goals in China and provide lessons learned for other developing countries in reducing the prevalence of malnutrition.

CONCLUSION

Our findings document that the nutrition policies and nutrition intervention programs the Chinese government promulgated during the MDGs period have improved maternal and child nutrition, especially undernutrition in children. Collectively, the nutrition policies have created a strong supportive environment for nutrition improvement in China, however, policies have put the main focus on reducing undernourished child and woman, and improving breastfeeding, with limited attention on overweight. In addition, there is a lack of legislation and regulations on nutrition. Overall, China has made major contributions to the rapid decline of undernutrition, and is likely with continued efforts to achieve the SDGs of child wasting, stunting, low birth weight and anemia in reproductive-age women.
However, further interventions and policies are needed to improve breastfeeding rates and to control and prevent childhood obesity.

ABBREVIATIONS

MDGs: The Millennium Development Goals; UN: United Nations; WHO: World Health Organization; EBF: exclusive breastfeeding; SGDs: Sustainable Development Goals; NGOs: non-governmental organizations; CNKI: China National Knowledge Infrastructure database; MoE: Ministry of Education; HFPC: National Health and Family Planning Commission of China; UNICEF: United Nations International Children's Fund; CDCs: Centers for Disease Control; CCTF: China Children and Teenager’s Fund; CDRF: China Development Research Foundation; ACWF: All-China Women's Federation; PAOSC: poverty Alleviation Office of the State Council; FAO: Food and Agriculture Organization; ILO: International Labor Organization; UNDP: United Nations Development Program; UNESCO: United Nations Educational Scientific and Cultural Organization; UNIDO: United Nations Industrial Development Organization; WFP: World Food Program; GAIN: Global Alliance for Improved Nutrition; MoA, Ministry of Agriculture; ILSI, International Life Sciences Institute.

DECLARATIONS

Competing interests The authors declare that they have no competing interests.

Authors’ contributions S.T., M.S. and Q.L. designed the research study. Q.L. and R.Z. performed the research. Q.L., X.H. and B.Y. analysed the data and wrote the manuscript. All authors read and approved the final manuscript. Ethics approval and consent to participate This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study
participants were approved by the Ethics Committee of Duke University (Ref number: 2017-1359). Verbal informed consent was obtained from all subjects. Verbal consent was witnessed and formally recorded. Consent for publication All authors reviewed this manuscript and provided consent for publication. Funding This work was supported by the Bill & Melinda Gates Foundation Grant number: OOP1148464. Acknowledgement This paper, as part of the outputs emanating from the project entitled “Achieving health related sustainable development goals in China: developing evidence-based options for actions” funded by the Bill & Melinda Gates Foundation (Grant number: OOP1148464) and led by Duke Global Health Institute with a partnership of several Chinese universities and organizations. The authors wish to thank Dr. Jiahui Zhang from the Development Research Center of the State Council of China, Prof. Jing Fang from Kunming Medical University, Prof. Hao Xiang from Wuhan University, and Jianduan Zhang from UNICEF for their assistance with contacting to the key interviewees. We also gratefully acknowledge the officials, nutrition project managers and professors who accepted our interviews. Availability of data and materials The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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**TABLES**

| Nutrition intervention policies | Issued department | Implemental duration (year) |
|---------------------------------|-------------------|-----------------------------|
| Outline for the Development of Chinese Children<sup>[17-18]</sup> | State Council     | 2001-2010                   |
| Outline for the Development of Chinese woman<sup>[19]</sup> | State Council     | 2011-2020                   |
| Outline for the Development of Food and Nutrition in China<sup>[20, 21]</sup> | State Council     | 2001-2010                   |
Infant feeding strategy [22]  MoH  2007–

Technical specification and guidance on child feeding and nutrition [23]  MoH  2012–

Plan of the national medium- and long-term education reform and  MoE  2010-2020
MoE, Ministry of Education; MoH, Ministry of Health;

| Program                                                                 | Target population                                      | Implemental Area                                      | Implement Duration (year) |
|------------------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------|---------------------------|
| Nutrition package for 6-24 months infants\(^{25}\)                     | Infants aged 6-24 months                               | 341 national poverty counties in 21 provinces         | Since 2012                |
| Integrated Early Childhood Development (IECD)\(^{27}\)                 | Infants aged 0-3 years                                 | 160 poverty villages in Shanxi and Guizhou province  | Since 2013                |
| Improving nutrition, food safety and food security for China's most vulnerable women and children (CFSN) \(^{28,29}\) | the high-risk population of 1.2 million children and women of childbearing age | in six of the poorest counties in western China       | 2009-2013                 |
| Supplementation of folic acid to prevent neural tube defects\(^{30}\)   | Women in the period of 3 months before pregnancy to the first trimester of pregnancy | Rural areas in China                                  | Since 2009                |
| Program                                                                 | Target Population                              | Coverage/Location                        | Start Date |
|------------------------------------------------------------------------|------------------------------------------------|------------------------------------------|------------|
| Nutrition Improvement Program for Rural Compulsory Education Students[^33] | Rural Compulsory Education Students (grade one to nine) | 699 poverty counties in 22 provinces     | Since 2011 |
| Milk plan for student in China[^36]                                    | Primary and middle school student in urban area | urban area                               | Since 2000 |
| Baby-friendly hospital[^38]                                             | Pregnant women, lactating women and baby        | Whole country                            | Since 1992 |
| Happy ten minutes[^39]                                                  | Primary students                                | Whole country                            | Since 2012 |

MoH: Ministry of Health; ACWF: All-China Women's Federation; PAOSC: Poverty Alleviation Office of the State Council; HFPC: Health and Family Planning Commission; FAO: Food and Agriculture Organization; ILO: International Labor Organization; UNDP: United Nations Development Program; UNESCO: United Nations Educational Scientific and Cultural Organization; UNICEF: United Nations International Children's Emergency Fund; UNIDO: United Nations Industrial Development Organization; WFP: World Food Program; GAIN: Global Alliance for Improved Nutrition; MoE: Ministry of Education; MoF: Ministry of Finance; MoA: Ministry of Agriculture; ILSI: International Life Sciences Institute.
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