

Potential Capacity of China's development assistance for health on neglected tropical diseases

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ARTICLE INFO

Keywords:

Neglected tropical diseases
Development assistance for health
SWOT analysis
China's experience

ABSTRACT

Neglected tropical diseases (NTDs) are important health problem in tropical and sub-tropical regions, which afflict more than a billion people worldwide and cause several million deaths every year, especially in Africa. The World Health Organization has called for global efforts to control and eliminate NTDs. China began its health assistance program from 1950s, especially on medical mission dispatched to more than 50 African countries. In this study, a SWOT analysis was used to analyze the current strengths, weaknesses, opportunities, and threats of China's health assistance relating to NTDs, in order to provide the recommendation to promote the activities on international assistance and cooperation on NTDs. Based on this analysis, interventions for NTDs and suggestions for future cooperation relating to NTDs are proposed. In the context of global health, China should strengthen and improve the capacity on health assistance for NTDs control.

1. Introduction

Global development assistance for health (DAH) increased from \$6.47 billion in 2000 (Yang et al., 2014) to \$40.6 billion in 2019 (Global Burden of Disease Health Financing Collaborator Network, 2020). However, the proportion of DAH for neglected tropical diseases (NTDs) is limited. For instance, NTDs made up less than 1% of total DAH, and infectious diseases (other than HIV/AIDS, malaria, and tuberculosis) accounted for 6% of the total DAH (Global Burden of Disease Health Financing Collaborator Network, 2020). Hence, there is a continued need for pandemic preparedness and development for controlling and eliminating NTDs (Moitra et al., 2021; Shajalal et al., 2017).

China's DAH began in the early 1950s in the form of medical supplies for Vietnam and North Korea. In 1963, China dispatched a medical team to Algeria, which was the start of sending medical teams to African countries. Since then, as a result of economic development and the international situation, China's health development has undergone three stages (Wang et al., 2015). First, during the foundation period

(1949–1978), China mainly provided medical supplies and medical aid to African countries. Second, during the period of adjustment and development (1979–1999), the main aid measures were to send medical teams, build hospitals, health centers, pharmaceutical factories, health schools, and other medical facilities, and carry out malaria control aids in Africa (such as building anti-malaria centers). Third, the rapid development phase (after 2000), other than the previously mentioned measures, the assistance measures were more diversified, including human resource development for health (for example, training health technicians and officers from developing countries) (Gao et al., 2018), health-related emergency humanitarian assistance, and South-South cooperation. More than 100 China-supported hospitals and medical service centers were built by the end of 2009 (The State Council of the People's Republic of China, 2011). It is estimated that China provides approximately \$60 million annually to Africa (Liu et al., 2014; Yang et al., 2018). Currently, China is becoming an emerging partner in the field of global health and international health assistance (Liu and Wang, 2015; Zhao et al., 2018).

; DAH, development assistance for health; NTDs, neglected tropical diseases; OECD, Organization for Economic Co-operation and Development; SDG, (United Nation's) Sustainable Development Goal; WHO, World Health Organization; SWOT, strengths, weaknesses, opportunities, threats.

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<https://doi.org/10.1016/j.actatropica.2021.106245>

Received 10 August 2021; Received in revised form 19 October 2021; Accepted 4 November 2021

Available online 25 November 2021

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Tropical diseases encompass all diseases that occur solely or principally in the tropics and subtropics, especially infectious diseases that thrive in hot and humid conditions and that often lead to epidemics in remote areas. However, some of these diseases are “neglected” and have been defined as neglected tropical diseases (NTDs) by the World Health Organization (WHO), with its portfolio of 17 tropical diseases in 2012 and 20 tropical diseases in 2017 (World Health Organization, 2020). NTDs are concentrated mostly in poverty-stricken regions in developing countries. According to the London declaration on neglected tropical diseases in 2012 (Uniting to combat neglect tropical diseases, 2012), NTDs were the focus of the WHO’s 2020 goals, including the eradication of Guinea worm disease, and the elimination of lymphatic filariasis, leprosy, sleeping sickness (human African trypanosomiasis), and blinding trachoma, and control of schistosomiasis, soil-transmitted helminths, Chagas disease, visceral leishmaniasis, and river blindness (onchocerciasis). Although great progress has been made in reducing the disease burden, many of the goals relating to NTDs set by the WHO for 2020 were not met (World Health Organization, 2020). In 2020, the WHO set the new roadmap with controlling and eliminating NTDs by 2030 in line with the United Nations Sustainable Development Goals (SDGs) (World Health Organization, 2020). More cross-regional, cross-national, and multi-sectoral actions will be required to accelerate the control and elimination of NTDs.

In the past, China experienced severe epidemics of NTDs (Li et al., 2017; Qian, 2017; Qian et al., 2019), especially of lymphatic filariasis, schistosomiasis, leishmaniasis, leprosy, and other serious diseases that threatened the health of Chinese people. Over several decades, China has made remarkable progress in the control and elimination of NTDs. However, control of NTDs in Africa and Asia remains grim.

As the world’s largest developing country, China can proactively participate in global cooperation to control NTDs and increase its influence in the field of DAH, based on China’s experience in the control of NTDs and the WHO’s 2030 roadmap for sustainable control of NTDs. It is essential to promote the China’s DAH program on NTDs, by conducting a study using SWOT analysis, to identify the internal strengths and weaknesses, as well as the external opportunities and threats. This will help analyze China’s DAH potential patterns regarding NTDs, which will provide a reference for either decision making process or middle/long-term planning regarding DAH for NTDs in the future.

2. Methods

2.1. Data collection

The data was collected from 187 sources of information, including literature, official documents, Chinese national website, WHO website, and other related sources. First, we searched PubMed database (www.ncbi.nlm.nih.gov) and China National Knowledge Infrastructure (CNKI) (www.cnki.net) up to 27 July 2021 without limitations with respect to language or type of article. The latter is a key national research and information publishing institution in China. 134 publications on the assistance on NTDs were found. The keywords for searching literatures were neglected tropical disease, development assistance for health, global health, and China. Second, we collected the documents of Chinese national plan for NTDs, Chinese strategy for DAH, and the statistical data from the Chinese national website, as well as the documents of global plan for NTDs from the WHO and United Nation’s website.

2.2. Performing the SWOT analysis

SWOT analysis (Wang and Wang, 2020), which is constructed on the SWOT model’s four matrices (Strengths, Weaknesses, Opportunities, Threats), was the qualitative analysis tool we used to evaluate China’s health assistance regarding NTDs, that is, the current strengths, weaknesses, opportunities, and threats as the basis for developing strategic

plans for the Chinese government to improve future DAH operations. Four different strategies can be developed from the SWOT model: the Strengths-Opportunity (SO) strategy, which involves seizing an opportunity and developing its advantages; the Strengths-Threats (ST) strategy, which builds on strengths and resolves threats; the Weaknesses-Opportunities (WO) strategy, which uses opportunities to address disadvantages; and the Weaknesses-Threats (WT) strategy, which draws lessons from experience to make up for the shortfall. Based on a SWOT analysis, we can understand the current situation clearly regarding internal factors and the external environment, and develop appropriate and applicable strategies to effectively utilize strengths and opportunities and avoid weaknesses and threats.

3. Results

3.1. Major achievements and current status of NTDs in China

Owing to the commitment of the China’s government and the application of multiple strategies for disease control, China has achieved unprecedented development and achievements in the control and elimination of NTDs (Qian et al., 2019; Wang et al., 2019). Table 1 shows the prevalence status and epidemic patterns of NTDs in China (Qian et al., 2019; The Disease Control and Prevention Bureau of the People’s Republic of China, 2021; Zhang et al., 2021; Zhou, 2018). China successfully eliminated lymphatic filariasis in 2007 and eliminated trachoma in 2015. Recognized by the WHO, China became the first country to eliminate lymphatic filariasis of the 83 endemic countries and regions in the world after WHO launched the Global Filariasis Elimination Program (Sudomo et al., 2010). In 2021, China has been awarded a malaria-free certification from WHO. These were most significant achievements in the field of public health since the eradication of smallpox and polio in China. Moreover, for schistosomiasis, it has achieved the transmission control criteria in whole country in 2015, which greatly accelerated the progress of schistosomiasis elimination program in China (Zhang et al., 2017). For visceral leishmaniasis, most endemic areas in China have been eliminated by 1958, and is now mainly concentrated in northwestern China (Qian et al., 2019; Zheng et al., 2010). For leprosy, it is generally at a low epidemic level in China, with the key endemic areas located in the southwestern provinces (Long et al., 2017; Qian et al., 2019). For clonorchiasis, a food-borne parasitic diseases, its prevalence has also been controlled widely but it has increased in some areas due to changes of social patterns in eating custom (Zhou, 2018). For the imported parasitic diseases, imported cases such as African trypanosomiasis, dracunculiasis, onchocerciasis, Chagas disease, and yaws are often reported although those diseases never transmitted in China, which should receive more attention. To further consolidate the achievements of tropical disease control, China has settled the target to eliminate schistosomiasis nationwide by 2030.

3.2. Strengths analysis

3.2.1. Economic development and health system improvement

According to statistical data regarding the economy and health sector (National Health Commission of the People’s Republic of China, 2020) (Fig. 1), China’s gross domestic product (GDP) has increased each year over the last two decades. The number of health institutes and the number of health workers have gradually increased. Owing to social development, especially economic upliftment, poverty-related diseases have been reduced, similar to NTDs (Hotez, 2019). Economic development exerts great impact on NTDs through diverse approaches. Subsequent water supplement and sanitation improvement can decrease soil-transmitted helminthiases, schistosomiasis, trachoma, echinococcosis, dracunculiasis, etc. The urbanization and established infrastructure in both urban and rural areas improve the living conditions, which could block the transmission of many NTDs, especially those transmitted through vectors. Traditionally small-scale agricultural economy is

Table 1
Prevalence of NTDs in China and the world.

| Name | Pathogen | Distribution and prevalence in China | Global distribution and Prevalence ^a | WHO 2030 Goals ^a |
|--|---|---|---|--|
| Dracunculiasis | <i>Dracunculus medinensis</i> (parasite) | Non-endemic | 54 cases, in four countries (2019) | eradication |
| Yaws | <i>Treponema pallidum</i> (bacteria) | Non-endemic | 80 247 cases, in 15 countries (2018) | eradication |
| Gambiense human African trypanosomiasis | <i>Trypanosoma brucei gambiense</i> (parasite) | Non-endemic (some imported cases) | Fewer than 1 000, in sub-Saharan Africa (2019) | elimination (interruption of transmission) |
| Leprosy (Hansen's disease) | <i>Mycobacterium leprae</i> (bacillus) | 200 new cases (2020), distributed mainly in western and southern area (The Disease Control and Prevention Bureau of the People's Republic of China, 2021) | 202 226 new cases, in 119 countries (2019) | elimination (interruption of transmission) |
| Onchocerciasis | <i>Onchocerca volvulus</i> (parasite) | Non-endemic | 21 million, in sub-Saharan Africa, Latin America and Yemen (2017) | elimination (interruption of transmission) |
| Chagas disease (American trypanosomiasis) | <i>Trypanosoma cruzi</i> (parasite) | Non-endemic | 6-7 million, in Latin America (2019) | elimination as a public health problem |
| Rhodesiense human African trypanosomiasis | <i>Trypanosoma brucei rhodesiense</i> (parasite) | Non-endemic (some imported cases) | 116 cases, in sub-Saharan Africa (2019) | elimination as a public health problem |
| Visceral leishmaniasis | <i>Leishmania</i> (parasite) | 202 new cases (2020) (The Disease Control and Prevention Bureau of the People's Republic of China, 2021) | 13 814 new cases, endemic in 75 countries (2019) | elimination as a public health problem |
| Lymphatic filariasis | <i>Wuchereria bancrofti</i> , <i>Brugia malayi</i> , <i>Brugia timori</i> (parasite) | Eliminated as a public health problem (2007) | 51.4 million, in 72 countries across African, Americas, Eastern Mediterranean, South-East Asia and Western Pacific regions (2018) | elimination as a public health problem |
| Rabies | Rabies virus and other lyssaviruses | 202 new cases (2020) (The Disease Control and Prevention Bureau of the People's Republic of China, 2021) | 29 million, in 89 countries, mostly in Africa and Asia (2015) | elimination as a public health problem |
| Schistosomiasis | <i>Schistosoma</i> (parasite) | 43 new cases (2020) (The Disease Control and Prevention Bureau of the People's Republic of China, 2021), mainly in 7 provinces (Zhang et al., 2021) | 236 million, in 78 countries, 90% of people requiring treatment live in Africa (2019) | elimination as a public health problem |
| Soil-transmitted helminthiasis | Intestinal parasites (<i>Ascaris lumbricoides</i> and <i>Trichuris trichiura</i>), hookworms (<i>Necator americanus</i> and <i>Ancylostoma duodenale</i>) and roundworms (<i>Strongyloides stercoralis</i>) | Estimated 29.1 million infected (2014–2015), mainly in 8 provinces (Zhou, 2018) | 1.5 billion, in 92 countries, mostly in sub-Saharan Africa, Latin America, Asia, and some areas of the European Region | elimination as a public health problem |
| Trachoma | <i>Chlamydia trachomatis</i> (bacterium) | Eliminated as public health problem (2015) | 137 million, in 44 countries (2020) | elimination as a public health problem |
| Buruli ulcer | <i>Mycobacterium ulcerans</i> (bacteria) | No accurate data available | 2260 new cases, in Africa, Latin America and the Western Pacific (2019) | control to a locally acceptable level |
| Dengue | Dengue viruses | 778 new cases with dengue (2020) (The Disease Control and Prevention Bureau of the People's Republic of China, 2021) | 104 million, mostly in Africa, Asia and Latin America (2017) | control to a locally acceptable level |
| Echinococcosis | <i>Echinococcus</i> | 3327 new cases (2020) | 1 million, in at least 111 countries, cystic echinococcosis is spread across all continents except Antarctica while alveolar echinococcosis is endemic in Asia, continental Europe and north America (2011) | control to a locally acceptable level |
| Foodborne trematodiasis | <i>Clonorchis sinensis</i> , <i>Opisthorchis viverrini</i> , <i>Opisthorchis felinus</i> , <i>Fasciola hepatica</i> , <i>Fasciola gigantica</i> and <i>Paragonimus spp</i> | Estimated 6 million infected with <i>C. sinensis</i> (2014–2015), high endemic in 4 provinces (Zhou, 2018) | 200 000 new cases annually, in 92 countries across all continents except Antarctica (2019) | control to a locally acceptable level |
| Cutaneous leishmaniasis | <i>Leishmania</i> (parasite) | No accurate data available | 277 224 new cases, endemic in 87 countries (2019) | control to a locally acceptable level |
| Mycetoma, chromoblastomycosis and other deep mycoses # | Bacterial or fungal | No accurate data available | No accurate data available | control to a locally acceptable level |
| Scabies and other ectoparasitoses ^b | <i>Sarcoptes scabiei var hominis</i> | No accurate data available | No accurate data available | control to a locally acceptable level |
| Snakebite envenoming ^b | Venomous snakebite | No accurate data available | 2.7 million annually, in 132 countries | control to a locally acceptable level |
| Taeniasis and cysticercosis | <i>Taenia solium</i> (parasite) | 36 6247 (2014–2015) (Qian et al., 2019) | 5.5 million, in more than 75 countries; the heaviest burden in Africa, Latin America and Asia. | control to a locally acceptable level |

Note:

^a Data from the WHO's new road map for NTDs (World Health Organization, 2020).

^b Categorized by the WHO as a neglected tropical disease in 2017.

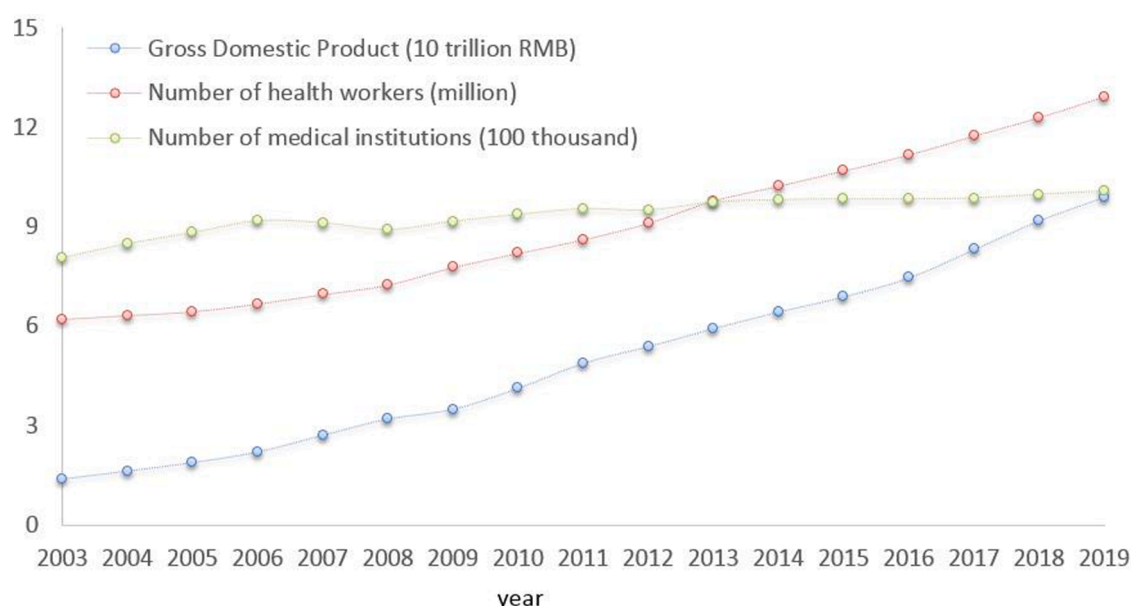


Fig. 1. Statistical data relating to China's economy and health sector from 2003 to 2019.

related to many NTDs, and the centralized and industrial breeding helps control many zoonotic NTDs.

3.2.2. Government commitment

Since the 1950s, disease control has become an important health issue. China has created a national disease control plan and established special funds for combatting schistosomiasis (National Health Commission of the People's Republic of China, 2017), leprosy (National Health Commission of China of the People's Republic of China, 2012), dengue (National Health Commission of China of the People's Republic of China, 2014), echinococcosis, leishmaniasis, clonorchiasis, soil-transmitted helminthiasis, taeniasis and cysticercosis (National Health Commission of the People's Republic of China, 2016), and animal rabies (Ministry of Agriculture of the People's Republic of China, 2017). The plans will be adjusted according to the epidemic level. NTD control was included in the China's government's "Healthy China 2030" plan (The State Council of the People's Republic of China, 2016), which set 2030 as the goal for the effective control of dengue, the elimination of malaria and schistosomiasis, and the control of endemic echinococcosis and other parasitic diseases. These factors promote public health coverage.

3.2.3. Multisectoral cooperation

Government commitment and multisectoral cooperation are the two keys for control of NTDs in China. For example, not only the health sector, but also the departments of agriculture, water conservancy, and forestry are required to implement a national control plan for schistosomiasis (The State Council of the People's Republic of China, 2006). Apart from the above-mentioned departments, the sectors of education, finance, science and technology, and food and drug supervision are also required to prevent and control other important parasitic diseases, including echinococcosis, clonorchiasis, leishmaniasis, soil-transmitted helminthiasis, taeniasis, and cysticercosis (National Health Commission of the People's Republic of China, 2016). The departments of health, development and reform, finance, civil affairs, human resources, security, education, publicity, and the Red Cross are involved in the control and elimination of leprosy (National Health Commission of China of the People's Republic of China, 2012). Due to the complexity of

NTDs, it is claimed that the mechanism of multisectoral cooperation is more effective in controlling NTDs, compared to efforts by the health sector alone.

3.2.4. Surveillance and response system

Since 2004, China has built and launched a surveillance and response system to monitor legislatively identified infectious diseases (Jin et al., 2006; Tambo et al., 2014; Zhou et al., 2016). Forty species of infectious diseases have been covered in this system, including lymphatic filariasis, echinococcosis, schistosomiasis, leprosy, leishmaniasis, and dengue. In addition, China has established a case management system for specific parasitic diseases (Li et al., 2010), such as clonorchiasis, ascariasis, hookworm disease, trichuriasis, taeniasis, and cysticercosis. Surveillance and response systems can monitor outbreaks dynamically and implement timely case management, not only to improve the accuracy of disease surveillance, but also to enhance the capability of early detection, which plays a crucial role in disease prevention, control, and elimination (Zhang et al., 2016).

3.2.5. Human resources of public health

China's medical universities usually set public health and preventive medicine as major subjects. Many universities offer parasitology as a major subject, or make parasitology a research focus. Researchers from national, provincial, municipal, and county centers for disease control and prevention as well as specialized institutes of parasitic diseases have accumulated rich practical experience through years of participating in different types of prevention and control projects on tropical diseases, which have greatly improved the capacity to control NTDs. In recent years, with the upsurge of attention on global health, many multidisciplinary centers of global health have been built in more than 20 universities, such as Peking University, Tsinghua University, Fudan University, Shanghai Jiao Tong University, and Wuhan University, which will inject new vitality into the cultivation of global health talent (Liu et al., 2014). With the establishment of the Chinese Consortium of Universities for Global Health (Liu et al., 2014), the China Global Health Network, and the Chinese Society of Global Health have also contributed to the development of the global health think tank and led to the cultivation of talent.

3.3. Weaknesses analysis

3.3.1. Sustainability of the projects and funding of health assistance

The pattern of China's health assistance has mainly included carrying out cooperation projects with recipient countries and personnel exchanges from both sides, and these activities have mostly been dependent on external funding, such as support from the WHO, the Global Fund, the Gates Foundation, and the government funds of developed countries, among others (Li et al., 2018). However, if such projects end, then the assistance faces a dilemma, or even stagnation. Fungibility of external funds should be maintained in those assistance project (Álvarez et al., 2016; Shalom et al., 2021). In recent years, China began to support the health assistance program on NTDs. In 2017, the Chinese government supported the implementation of the China-Tanzania's Zanzibar schistosomiasis control project, which was the first China-Africa cooperation project on schistosomiasis. Although assistance funds for NTDs in the world are very limited, China's donations make it a potential power (Shajalal et al., 2017). However, China has not established a management mechanism for health development assistance for NTDs. China's assistance for NTDs is relatively simple and dispersed, making it difficult to consolidate its strength, which leads to a limited impact on the health system of the recipient countries. In addition, the cumbersome customs formalities for medical equipment and medicines, as well as improper transport and use of drugs, have also affected the process of assistance. The sustainability of China's assistance regarding NTDs needs to be strengthened, as well as the management mechanism of health assistance projects.

3.3.2. Lack of health assistance experience

Developed countries have a long history of providing health assistance. However, China's experience with NTD assistance is limited. Unlike the OECD (Organization for Economic Co-operation and Development) countries, which have an aid priority that is focused on specific diseases (Wang et al., 2014), China's aid has focused on constructing health facilities, dispatching medical teams, and training medical workers, but very few programs focused on specific diseases. In general, China's DAH has given priority to "hard" aspects such as health facilities, while the investment in "soft" aspects such as health knowledge, experience, and products, such as supplying drugs, devices, and vaccines; construing disease diagnosis standards; and professional health advising is limited (Grepin et al., 2014). The differences in terms of assistance priority between China and OECD countries has resulted in China getting more experience in "hard" health matters but limited experience in "soft" health aspects. Due to the lack of systematic data to assess China's health assistance, it is difficult to determine its feasibility and applicability (Grepin et al., 2014).

3.3.3. Needs of domestic disease control

Two NTDs have been eliminated in China; however, some NTDs still need national support, including echinococcosis distributed in the western region of China, and leishmaniasis in the northwestern region of China. Some regions still face problems related to insufficient health resources.

3.3.4. Lack of global health talents

Along with the progress of globalization, the traditional human resources of public health and preventive medicine could not meet the demand for DAH, and global health talent is required. Moreover, the global human cost becomes apparent (Ruger et al., 2015). However, the discipline of global health, which has grown in popularity since the 1990s, is still in its infancy. Traditional public health is only built on the health sector alone to control diseases, which is significantly different from global health. The social and environmental aspects of public health have been slow to be recognized in the educational system. Professionals of global health need to master not only medicine, law, economics, management science, informatics, and other

multidisciplinary knowledge, but also need to understand the culture, religion, and health systems of different countries (Xiang et al., 2015). More importantly, these professionals require the ability to discover, analyze, and solve cross-border health problems from a global perspective and solve global health problems using interdisciplinary and multisectoral resources. In addition, with the elimination of diseases, the strength of disease prevention and control personnel is weakened, and ways to maintain this talent team is also a problem that will have to be faced.

3.4. Opportunities analysis

3.4.1. The demand for global tropical diseases control

In 2015, the United Nations proposed as one of its Sustainable Development Goals the elimination of epidemics such as AIDS, tuberculosis, malaria, and neglected tropical diseases by 2030 (United Nations, 2015). As early as 2012, the WHO issued a global strategy for the prevention and control of neglected tropical diseases and signed the London Declaration, proposing the goal of eliminating or controlling NTDs by 2020 (World Health Organization, 2012). Recently, the WHO updated the NTDs roadmap 2021–2030 (World Health Organization, 2020), which aimed to guide work to control and eliminate NTDs to reach the SDG. According to the WHO estimates, Table 1 shows the global prevalence of NTDs and the goals set for 2030. Thus, it can be seen that NTDs are seriously harmful and widespread, and global action to overcome them is urgently needed.

3.4.2. "Belt & Road" initiative and Forum on China-Africa Cooperation

In recent years, China's assistance to African countries has been increasing, and China has become one of the top 10 global health donors to Africa (Grepin et al., 2014). The Chinese government has strengthened health assistance to "Belt and Road Initiative" countries and other African countries. In 2013, China began to implement the Belt and Road Initiative (Tang et al., 2017). In January 2017, China and the WHO signed the "Belt & Road" memorandum of understanding on health. In July 2017, China and the WHO signed an implementation plan, including the control of tuberculosis, malaria, and schistosomiasis. In August 2018, the Beijing Action Plan was announced in the Forum on China-Africa Cooperation, in which support was promised to African countries to control tuberculosis, malaria, and schistosomiasis, and the establishment of the African Centers for Disease Control (Ministry of Foreign Affairs of the People's Republic of China, 2018).

3.4.3. Development of diagnostic and therapeutic tools

Currently, the application of new technologies represented by biotechnology, such as pathogenic biology, genomics, proteomics, and bioinformatics, has effectively revealed the biological characteristics of NTDs and they promote pathogenesis research, prevention technologies, and drug development (Utzinger et al., 2012). These factors further promote the development of prevention and control of NTDs (Albonico et al., 2015; Taylor, 2020). Although there are no vaccines for any of the NTDs, the development of safe and effective vaccines is required for global control of NTDs, and biotechnology has effectively promoted the development of vaccines. Deep learning-based image detection was used to analyze helminths infection in resource limited areas (Oscar et al., 2017). Nucleic acid technologies have been successfully applied to the diagnosis of schistosomiasis (Weerakoon et al., 2018). The development of drugs (praziquantel, albendazole, and clonidamide) has greatly promoted the prevention and treatment of NTDs globally (Kasinathan and Greenberg, 2012), and international communities are encouraged to commit to the control of NTDs (DNDi, 2021; *Uniting to combat neglect tropical diseases*, 2012).

3.4.4. International partnerships

China has built 65 WHO Collaborating Centers (World Health Organization, 2021), three of which are related to NTDs, including the

WHO Collaborating Center for Tropical Diseases, the WHO Collaborating Centre on Schistosomiasis Control in Lake Regions, and the WHO Collaborating Centre for Prevention and Management on Echinococcosis. Through these WHO Collaborating Centers, cooperation between China and the WHO has gradually increased, which has laid an important foundation for strengthening cooperation between China and the WHO on NTDs. In addition, international partnerships and status have increased through bilateral and multilateral cooperation (Hui and Di, 2015). Joint action and cooperation among partners are required to carry out assistance projects.

3.5. Threats analysis

3.5.1. Difference between China and recipient countries

The differences in economic level, culture and customs, health system, disease control strategies, and endemic status of NTDs between China and recipient countries may be another challenge for health assistance. When coping with Chinese experience and skills, including health assistance concepts and models, technologies, and products, recipient countries may face challenges if simply adopting Chinese skills. Besides, ethical dimensions are unavoidable challenges while pursuing NTDs program in recipient countries (Addiss et al., 2021).

3.5.2. Challenges from other threats

A stable and secure environment is the important basis when China makes the health assistance plans (Lin et al., 2016). Obviously, the troubled situation in local areas affects the implementation and effect of the assistance projects. Emerging infectious diseases, such as COVID-19 (Ehrenberg et al., 2021; Mejia et al., 2020), and other key infectious diseases will squeeze the concern of NTDs, leading to lack of funds, resources, and research for NTDs. Donor transition and proliferation will be an important impact to the aid effectiveness (Gilbert et al., 2019; Wood and Prah, 2017).

The results of the SWOT analysis are shown in Table 2.

4. Discussion

SWOT analysis is a useful tool for understanding current strengths and weaknesses, and for identifying opportunities and threats. In this paper, the results of the SWOT matrix not only provided a framework for the benefits and limitations of the current situation, but also laid a base to bring forward four strategic choices for China's DAH on NTDs.

Table 2
SWOT matrix of China's development assistance for health on NTDs.

| Internal Factors and External Environment |
|---|
| 1. Internal Strengths |
| Economic development and health system improvement |
| Government commitment |
| Multisectoral cooperation |
| Surveillance and response system |
| Human resources for public health |
| 2. Internal Weaknesses |
| Sustainability of the projects and funding of health assistance |
| Lack of health assistance experience |
| Needs of domestic disease control |
| Lack of global health talent |
| 3. External Opportunities |
| The demand of global tropical diseases control |
| "Belt and Road" Initiative and China-Africa health cooperation |
| Development of diagnostic and therapeutic tools |
| International partnerships |
| 4. External Threats |
| Difference between China and recipient countries |
| Challenges from other threats |

Note. NTDs, Neglected tropical diseases.

4.1. SO strategy, priority recommended

As China has become the world's second largest economy, implementation of health assistance, which can improve health and reduce poverty (Bendavid et al., 2017), is not only to fulfill the Chinese government's commitments, but also to promote global control of NTDs. Of the 20 NTDs referred to earlier, five are non-endemic, while two have been eliminated. Through efforts over several generations, China has gained rich experience in controlling endemic NTDs and in moving these diseases from control to elimination. First, in order to use the resources fully and reasonably, systems thinking approach needs to be used when policymakers design the health assistance plans for overcoming the complex NTDs (Jeffrey et al., 2020). The second priority, then, is to refine and summarize the feasibility of China's experience in controlling NTDs, including the organization and management system, cooperation pattern among sectors, control strategies and measures, skills and products, as well as the experience of monitoring, interventions, diagnosis, and treatment, which should be integrated into a set of guides that can be directly applied in recipient countries. The story of how China typically controls and eliminates NTDs should also be summarized and explained. Full use of these experiences should be made. The next priority is that because the surveillance and response system is a key tool for the control of NTDs, especially in the stage from disease control to disease elimination, it is necessary to extend the surveillance and response system, including improving the functions and adding more diseases. Next, China has technological advantage and manufacturing prowess, especially in the control of COVID-19, so it is also necessary to develop new tools and skills for the benefit of NTDs, as well as therapeutic drugs. Finally, the establishment of pilot projects is recommended over the next five years, with schistosomiasis and food-borne trematodiasis, soil-transmitted helminthiasis, trachoma, echinococcosis, dracunculiasis as priorities.

4.2. ST strategy, positive choice

Peaceful development and international cooperation are current themes. China should actively participate in global health governance. However, it is unavoidable that China's experience when directly applied to African countries will result in challenges because of differences in culture, language, religion, policy system, and disease characteristics. How is China to take advantage of opportunities to deal with such challenges? First, because NTDs are endemic to the most poverty-stricken areas, as the largest developing country, China should foster cooperation with other developing countries (South-East Asian countries and African countries). Second, China should formulate a national global health strategy and the departments of health, diplomacy, education, and other related departments should jointly carry out NTDs assistance programs. Third, China should learn from and use successful experiences to guide future development, including innovating the assistance models, management systems, and working mechanisms, and improving the technologies and skill levels, which can contribute to the betterment of future health assistance and cooperation projects. For example, helping recipient countries set up tropical disease control plans, export products such as drugs and diagnostic reagents, and establish standardized aid evaluation indicators. Fourth, before the assistance project begins, it is necessary to understand the political, economic, cultural, and endemic disease situation in the recipient country, as well as their priority needs and the challenges they face, and then determine how best to share Chinese experience and technologies according to the local conditions.

4.3. WO strategy, conservative choice

China has repeatedly made aid commitments to Africa. Both the Belt and Road Initiative and China-Africa health cooperation have contained tropical disease assistance. In addition, international organizations and

foundations are seeking partners, expecting to carry out joint efforts on health assistance; therefore, China's experience of tropical disease control is highly compatible with the global needs of tropical disease prevention. First, China should strive for national and international support and launch a number of ongoing cooperation projects with national and international partners to assess the applicability of the Chinese experience. Second, China should learn from international health aid projects to gain a better understanding and experience of health assistance. For example, US aid mainly provides health assistance in health policy formulation, high-level political cooperation, technical support, and personnel training. Third, China should enlarge domestic health support to achieve the goal of combating NTDs early in China. Fourth, China needs to cultivate comprehensive global health talent. In the era of global health, professionals engaged in tropical disease control must not only be equipped with rich public health knowledge, but also possess a strong international diplomatic ability. The global expert team of health aid and tropical disease control should be strengthened through the introduction, training, and exchanges of talent.

4.4. WT strategy, resistive choice

Globalization has accelerated new trends in global health governance and complicated the international situation. However, opportunities and risks coexist. The need for global control of NTDs provides an opportunity for China to provide health assistance, and there is an urgent need to improve the cooperation level and capacity of China's health assistance. Similarly, risks also need to be addressed. China should avoid threats and weaknesses and must strengthen assistance projects related to NTDs. First, the instability of funding sources may lead to the freezing of aid projects. If funds are limited, China should prioritize health assistance areas to develop and avoid out-of-budget projects. Second, avoid the obvious incoherence with other global health donors when developing the aid projects (Pallas and Ruger, 2017). Third, to avoid the risks, before the launch of a project, China should conduct comprehensive investigations and surveys. After the project is launched, China should emphasize dynamic management, coordination, supervision, and regular evaluation. Fourth, the tensions in recipient countries may jeopardize the health security of aid workers. Emergency measures must be made to ensure their safety (Jessica et al., 2020). It is essential to keep up with the international situation, plan ahead, and take preventive measures.

The strategies for China's DAH pertaining to NTDs as determined by the above analysis are shown in Table 3.

5. Conclusion

Based on the SWOT analysis, the internal strengths and weaknesses of DAH pertaining to NTDs as well as the external opportunities and threats corresponding to the strategies at top level can be clearly observed in the context of global health. To further improve health assistance for tropical diseases, China needs to concentrate on refining its skills and experience for NTDs control and elimination, formulate a health assistance strategy, conduct cooperation pilot research projects in recipient countries, and strengthen the construction of global health assistance teams. In addition, the arrival of the global health era has brought new opportunities for the field of DAH. It is therefore necessary to build a top-level health assistance strategy and encourage professionals to make use of their own advantages to promote the progress of global control of NTDs.

Funding

This work was supported by the Chinese National Center Programme of Tropical Diseases Research (No. 131031104000160004).

Table 3

Four strategic choices of the development assistance for health on NTDs in China based on SWOT analysis.

| Strategic combination | Concrete measures |
|-----------------------|---|
| SO Strategy | Systems thinking approach application in health assistance plans Refine and summarize China's experience Surveillance and response system Develop new tools and drugs Establish pilot projects |
| WO Strategy | Develop cooperation with other developing countries Formulate a national global health strategy Learn from successful experiences of health assistance Understand the situation in the recipient countries |
| ST Strategy | Strive toward national and international support Learn from the international health aid projects Enlarge the domestic health support Cultivate global comprehensive talents |
| WT Strategy | Choose the priority areas Avoid incoherence with other global health donors Strengthen project management Predict the risks of aid projects |

Note. NTDs, Neglected tropical diseases; SO Strategy, Strengths-Opportunity strategy; WO Strategy, Weaknesses-Opportunities strategy; ST Strategy, Strengths-Threats strategy; WT Strategy, Weaknesses-Threats strategy.

Data sharing

Please contact author for data requests.

Ethics consent

Not applicable.

Abbreviations

DAH: development assistance for health; NTDs: neglected tropical diseases; OECD: Organization for Economic Co-operation and Development; SDGs: (United Nation's) Sustainable Development Goals; WHO: World Health Organization. SWOT: Strengths, Weaknesses, Opportunities, Threats.

CRediT authorship contribution statement

Hong-Mei Li: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Men-Bao Qian:** Investigation, Validation, Writing – review & editing. **Duo-Quan Wang:** Conceptualization, Writing – review & editing. **Shan Lv:** Resources, Supervision, Writing – review & editing. **Ning Xiao:** Resources, Validation, Writing – review & editing. **Xiao-Nong Zhou:** Conceptualization, Methodology, Funding acquisition, Writing – review & editing.

Declaration of Competing Interest

The authors have declared that no competing interests exist.

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