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Two young boys look on as their new school is built in the Garden compound slum in Lusaka, Zambia. Achieving universal primary education is the second of the UN's Millennium Development Goals. Between 2000 and 2011, the number of children out of school declined from 102 million to 57 million. However the 2013 report on this MDG states stalled progress means that the world is unlikely to meet its target by 2015.

Photograph taken by Ewan D. Kennedy, an Edinburgh medical student working on this building project, summer 2010.

Journal of Global Health: The Mission Statement

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Photo: courtesy of Dr Martin Willi Weber, personal collection

The *Journal of Global Health* is a peer-reviewed journal published by the Edinburgh University Global Health Society, a not-for-profit organization registered in the UK. The *Journal* publishes editorials, news, viewpoints, original research and review articles in two issues per year.

The *Journal*'s mission is to serve the community of researchers, funding agencies, international organizations, policy-makers and other stakeholders in the field of international health by:

- presenting important news from all world regions, key organizations and resources for global health and development;
- providing an independent assessment of the key issues that dominated the previous semester in the field of global health and development;
- publishing high-quality peer-reviewed original research and providing objective reviews of global health and development issues;
- allowing independent authors and stakeholders to voice their personal opinions on issues in global health.

Each issue is dedicated to a specific theme, which is introduced in the editorial and in one or more viewpoints and related articles. The news section brings up to five news items, selected by the *Journal*'s editorial team, relevant to seven regions of the world, seven international agencies and seven key resources important to human population health and development.

We particularly welcome submissions addressing persisting inequities in human health and development globally and within regions. We encourage content that could assist international organizations to align their investments in health research and development with objective measurements or estimates the disease burden or health problems that they aim to address. Finally, we promote submissions that highlight or analyse particularly successful or harmful practices in management of the key resources important for human population health and development.

All editors and editorial board members of the *Journal* are independent health professionals based at academic institutions or international public organisations and so are well placed to provide objective professional evaluation of key topics and ongoing activities and programs. We aim to stay true to principles of not-for-profit work, open knowledge and free publishing, and independence of academic thought from commercial or political constraints and influences. Join us in this publishing effort to provide evidence base for global health!

March 7, 2011 — The Editors, *Journal of Global Health*

EDITORIAL

mHealth series:
New ideas for mHealth data collection implementation in low– and middle–income countries

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The use of mobile devices in healthcare, or mHealth, has the potential to play an important role in low– and middle–income countries in a wide range of areas. A particular area with great potential to improve global health is using mHealth for data collection. We propose three ideas: (i) to validate and conduct household surveys, (ii) to monitor large–scale programs, and (iii) to measure the global burden of disease.

The use of mobile devices in health care, or mHealth, has the potential to play an important role in low– and middle–income countries. The widespread use of mobile devices and almost universal coverage of the world's population by a network signal has given mHealth a great opportunity to improve global health. There is a very significant interest in using mHealth as an additional strategy for strengthening health systems and achieving the Millennium Development Goals in low– and middle–income countries. However, mHealth has not reached its promised potential [1].

While there is a large amount of literature in the mHealth field in a wide range of areas, many mHealth projects have been small–scale pilots and very few have been thoroughly evaluated. The results of mHealth studies have been mixed and there is insufficient evidence of mHealth impact on health indicators [1,2]. The difficulties in defining and evaluating mHealth reflect on broader challenges in interpreting the complex interactions between technology, health care service designs and people. An additional problem for mHealth in low– and middle–income countries is that more mHealth efforts and evaluations have taken place in high–income countries [1].

More efforts should focus on mHealth data collection, because mHealth has great potential to improve the availability and quality of health data [3]. Accurate data are needed to evaluate health, assess effectiveness of interventions, monitor trends, inform health policy, and set priorities. However, data are often lacking and of insufficient quality, because data collection faces several challenges. Some of these challenges are inherently caused by the current data collection methods, such as face–to–face and pen–and–paper methods. Current data collection is limited by resource constraints, both in terms of personnel and financial costs. There is a short supply of trained and qualified interviewers and health workers, and data collection is often perceived as time–consuming, complex, inflexible and not useful. As a result, data are frequently fragmented, inaccessible, incomplete, and prone to error [4].

To address the problem of resource constraints, mHealth could offer a scalable solution needing minimal personnel, time, and financial resources to collect data. mHealth data collection may be more convenient for data collectors and those who provide information. Moreover, mHealth opens up new possibilities to validate and collect data. We propose three ideas where mHealth could be implemented for global health: (i) to validate and conduct household surveys, (ii) to monitor large–scale health programs, and (iii) to measure the global burden of disease.

First, large–scale household surveys are needed to provide accurate estimates of health and to measure coverage of health interventions. Population–based data that are de-

rived from these surveys will continue to provide information in the foreseeable future in low– and middle–income countries, even when health information systems improve [5]. Surveys are needed to validate data obtained through other sources; for example information on care–seeking of caregivers for their child's health, which is particularly limited in terms of quality and quantity [6].

Currently, some health indicators may not provide fully accurate results. Efforts to learn more about measurement using innovative designs to asses accuracy would be welcomed [5]. mHealth could evaluate and improve accuracy of reporting [7]. Mobile devices could be used to show caregivers videos on dangers signs for which care needs to be sought and this can also serve as a health education intervention to improve care–seeking behaviour. In addition, mobile phones could validate reports on care–seeking by monitoring caregivers' health care attendance via a mobile phone and comparing this data with information about caregivers' care–seeking behaviour collected by household surveys.

Mobile phone text messaging could be a cheaper and quicker method to conduct surveys, because no households have to be visited. In this issue of the *Journal of Global Health*, we explored how maternal, newborn and child health coverage can be measured by text messaging in China. Text messaging data collection can eliminate interviewer bias, and could increase sample size and representativeness by including hard–to–reach populations [8].

Second, effectively monitoring and evaluating large–scale health interventions is essential for planning and management of programs and to achieve high coverage of key health interventions. There are a number of large–scale international efforts that aim to improve health in low– and middle–income countries, but monitoring these efforts is often challenging. Current collection of data is time–consuming, slow and often provides out–of–date information. Continuous data collection would be particularly beneficial for evaluating interventions at scale [9]. mHealth could facilitate evaluation of these efforts by allowing data to be collected in real time [10].

Third, there is a need for global, national and regional information about the burden of disease. Especially regional data are needed, because there is substantial geographical variation in the causes of deaths, and appropriate interventions have to be tailored to a specific context to be effective. However, there are large gaps in the burden of disease, particularly in low– and middle–income countries where most deaths occur. Moreover, the local relevance of much health information is questionable [3]. The ubiquity of mobile phones allows easy scale–up of data collection and its use in different settings. mHealth interventions could collect data for different data sources that are used for global burden of disease measurements.

However, before implementing these mHealth applications, we need to know more about the evaluation of mHealth interventions and their validity to maximise their potential [2]. More field sites are needed that rigorously evaluate and validate mHealth for implementation of effective mHealth interventions. Therefore, we set up a collaboration between researchers in China and in the UK to evaluate mHealth in a field site in rural China. In this issue of the *Journal of Global Health*, we introduced the aims and objectives of our mHealth project, the field site, and the detailed methods of two studies that we conducted [11].

In the first study, we explored factors influencing sample size calculations for mHealth studies [12]. Realistic sample size calculations are essential to conduct mHealth–based studies, but we had very little information available that could be used to inform our sample size calculation. Participants can be lost during different steps in mHealth studies, including collection of names of potential participants and their mobile phone numbers, recruitment, and data collection and follow–up [8]. There are several factors influencing whether people are lost during each step; for example the proportion of people that own and are able to use a mobile phone, how they are recruited, their response rate, and willingness to participate over time. We used mixed methods to explore factors in the different steps. This work can help future mHealth studies with estimating their sample sizes.

In the second study, we determined the validity of mHealth text messaging data collection. The effects on data quality of this mode of data collection are unknown and the validity of a new data collection mode needs to be established. We conducted a cluster randomised cross–over study and included a large sample of participants. We compared a text messaging survey vs a face–to–face survey and assessed a range of outcomes: data equivalence, the amount of information in responses, reasons for different responses, the response rate, characteristics of non–responders, and error rate. This work can help future mHealth studies with developing their mHealth interventions.

The potential that the widespread use of mobile phones offers to health care should go beyond exploration. mHealth efforts should focus on effective use of validated mHealth interventions to improve health in low– and middle–income countries. The three areas in which we think that mHealth could play a significant role for global health are to validate and conduct household surveys, to monitor large–scale programs, and to measure the global burden of disease. We set up a mHealth project in rural China to rigorously evaluate and validate an mHealth intervention and contribute to the evidence base of mHealth for global health. In the next years, we hope that more efforts will evaluate mHealth sufficiently, so that it can be successfully implemented.

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Africa

The African Development Bank published a review of health within Africa over the past 50 years, looking at health patterns and trends, and the challenges of the next 50 years. Fifty years marks the independence of many African countries from colonial rule. It highlights the improvement in life expectancy (from 38 years in 1958 to 56 in 2012), and successes in improving maternal, infant and under–five child mortality rates. In the future, Africa faces the burden of growing non–communicable diseases (eg, cancer, type 2 diabetes), whilst still grappling with high incidences of communicable diseases (eg, malaria, and HIV/AIDS). Moreover, it faces shortages of health professionals and unequal access to health care. Climate change may pose severe threats to health, as changes in temperature, rainfall and humidity could increase vector–borne infectious diseases. (*AfDB*, 31 Mar 2013)

At the recent World Health Assembly, Nigeria announced a 67% fall in Wild Polio Cases (WPV). It also reported that no type 3 polio virus (WPV3) has been discovered since November 2012, circulating genotypes have collapsed from fourteen to two, and that North West Nigeria is no longer an epicentre of polio. To reach more children, including these in areas where states of emergency had been declared, Nigeria called for more availability of vaccinations that are simple to administer and store. Concerns were raised about the growing cost of child vaccinations, and lack of global control over prices. (*The Guardian*, 23 May 2013)

The future well-being of millions of African people may rest in the unlikely hands of a vegan hippy scientist. Mr Howard–Yana Shapiro, the agriculture director of the US$ 36 billion US confectionery corporation Mars, who sequenced and published the complete genome of the cacao tree in 2010, now plans to map and then give away the genetic data of 100 traditional crops including yam and cassava. These "orphan crops" are ignored by scientists, seed companies and governments – who all rather focus on maize, rice and soya – but are a staple for up to 250 million smallholder African farmers who depend on them for food security, nutrition and income. Shapiro describes the huge potential to develop more resilient and higher–yielding varieties of most orphan crops by combining traditional plant breeding methods with new biotech tools. "The genetic information will be put on the web and offered free to plant breeders, seed companies and farmers on condition it is not patented. A new African plant–breeding academy will also be set up in Nairobi, Kenya." It is a gift to start an initiative to boost African farming. (*The Guardian*, 2 Jun 2013)

The UN warned of a severe outbreak of polio in Somalia, with at least 105 cases of polio have been recorded in Somalia this year – almost half the number of cases around the world in 2012. Somalia was declared polio–free in 2007, and about four million people have been vaccinated. Most of the Somali cases are in areas controlled by militants. The outbreak in Somalia has spread to neighbouring Kenya, where 500 000 Somalis have fled. (*Philadelphia Inquirer*, 17 Aug 2013)

UN AIDS congratulated the President of Uganda, Yoweri Museveni and the First Lady Janet Kaguta Museveni for their renewed commitment to the Ugandan HIV response. To encourage more Ugandan citizens to know their HIV status, President Museveni took a public HIV test at a health centre in Kampala. At the event, he urged all Ugandans to know their HIV status and to access testing and counselling. He stressed that anyone living with HIV would receive a package of care, treatment and support. He also called on everyone to avoid risky sexual behaviour. The campaign aims to reach 15 million people by the end of 2014. In Uganda, 577 000 people living with HIV are accessing life–saving treatment, and part of the campaign will ensure than an additional 240 000 people will receive treatment by the end of 2014. (*UN AIDS*, 8 Nov 2013)

Asia

A simple invention by Dr Mohammad Abdul Quaiyum at the International Centre for Diarrheal Disease Research in Bangladesh helps to identify life–threatening haemorrhaging in women who have just given birth. He has invented a small birthing mat, which is designed to absorb 400 ml of blood during labour. If a woman loses more, the mat gets saturated, indicating that the woman is haemorrhaging and needs urgent medical help. It was tested by a charity that distributes birthing kits to pregnant women. It was added to their existing kits, with a drug to control haemorrhages. 77 000 kits were distributed, and Dr Quaiyum's follow–up survey found that 97% said that the mat was beneficial, and that 37 fewer–than–expected new mothers had died – achieved at a cost of 50 cents per mat. (*The Economist*, 18 May 2013)

Japanese researchers have developed a vaccine that cuts the risk of malaria by 72%. WHO estimates that malaria causes 660 000 deaths per year, mostly children in Africa, where it kills one child each minute. The new vaccine, BK–SE36 targets the most dangerous species of the malaria parasite, *Plasmodium falciparum*, at its blood parasite stage. It underwent initial trials in Japanese adults and has now been tested in a malaria endemic area in Northern Uganda. Its safety and immunogenicity has been assessed, and evidence shows that it will cut malaria infections by 72%. Additional data for safety, tolerability and adverse reactions will be collected in larger trials in younger children. (*PLoS ONE*, 28 May 2013)

Bangladesh is now one of Asia's fastest–growing economies, and out–ranks India on some measures of social welfare, such as child mortality. However, its growth potential and ability to lift more of its people out of poverty is hampered by endemic problems in its political system, such as corruption, and the harassment and prosecution of Opposition politicians. Bangladesh's problems are thrown into relief by the recent Rana Plaza disaster, where 1100 people were killed and 2500 injured by a collapsed factory. The building was deemed unfit, and workers were sent home – but then ordered back to work the day before it collapsed. Culpability has been pinned on the government for not enforcing existing legislation to prevent such tragedies. This lack of enforcement, and related political unrest, is deterring other investors, to the detriment of Bangladesh and its people. (*Financial Times*, 5 Aug 2013)

WHO and the Damascus government confirmed the first outbreak of polio in war–torn Syria for 15 years, in the eastern province of Deir al–Zour. WHO reported 10 confirmed cases, and another 12 being investigated, all affecting babies and toddlers. Prior to the outbreak of war in 2011, 95% of Syria's children were immunised. Since then, an estimated 500 000 children are unvaccinated, leaving them at risk of contracting this incurable disease, whose potential complications include paralysis. The city of Deir al–Zour remains in partial control by forces loyal to President Bashar al–Assad while the opposition holds the surrounding countryside. Given the highly dangerous situation, both government and rebel fighters were urged to respect "vaccination ceasefires" to permit access to the hundreds of thousands of children threatened by an outbreak of polio. It is hoped this news will spur international attempts to secure safe passage for humanitarian relief workers. (*The Guardian*, 29 Oct 2013)

Typhoon Haiyan struck the Philippines in November 2013, causing death and destruction on a massive scale. Homes and crops that survived the first onslaught were left at the mercy of ensuing flooding and landslides. The city of Tacloban felt the full force of the storm. Mr Manuel Roxas, the interior secretary, likened the scale of destruction to a tsunami. Early relief efforts were rendered almost useless as water, electricity and telecommunications were cut off, roads were blocked and bridges swept away. The final death toll may reach 10 000 people, with hundreds of thousands left homeless. Looking ahead, the Philippines disaster risk–reduction and management systems must be overhauled, as they could not cope with Typhoon Haiyan, a disaster on an extraordinary scale. (*The Economist*, 11 Nov 2013)

Australia and Western Pacific

An Australian proposal to allow childcare centres and schools to ban unvaccinated children has sparked controversy. As a signatory to the UN Convention of the Rights of the Child, Australia agreed that "the best interests of the child shall be a primary consideration." The Convention states that every child has the right to "the highest attainable standard of health," and immunisation saves an estimated 2–3 million lives each year, and benefits massively outweigh risks. In recognition, the UN states that all children should be immunised. But banning non–vaccinated children from schools and childcare risks violating Article 28 of the Convention, whereby education is compulsory and freely available. This shows that parental education should be used to ensure vaccination, rather than punitive measures which may violate children's right to an education. (*Science Alert*, 24 May 2013)

During a 14–hour visit to Australia, Mr Bill Gates raised an extra US$ 75 million from the Prime Minister for his polio campaign. His major focus is eradicating polio and he's down to just three countries with 300 cases, and gives himself a good chance of eradicating it. Cervical cancer is his next vaccination focus. He pointed out that the Foundation does not invest in tobacco or weapons companies. He believes that governments should tackle corporate tax minimisation and avoidance through laws, rather than expecting companies to do so voluntarily. He also said that he isn't planning to freeze or clone himself as a way to cheat death. "Life is great but you have to make room for people who come after you," he said. (*news.com.au*, 24 May 2013)

The number of children contracting the most common strains of potentially fatal pneumococcal disease fell by

97% in Australia since universal vaccination began in 2005. Unvaccinated adults also benefit from the widespread immunization of infants. It mainly affects children under two and the elderly, and those who develop meningitis risk brain damage or death. Since the introduction of the universal vaccination for under–twos in 2005, severe infection caused by the seven most common strains of pneumococci had plunged from 60.9 to 2.1 per 100 000. More work is needed to increase uptake of the vaccine amongst Australia's indigenous people and other groups with certain risk factors. (*The Conversation*, 27 May 2013)

▸▸ Australia has become the first country to offer the human papilloma virus (HPV) vaccine to 12-year–old boys. It has been available since 2007 and is administered to girls to prevent HPV infections and associated cervical cancer. Australia has a higher mortality rate in men from HPV–associated cancers (mainly oral cancers), compared to women. Worldwide, an estimated 600 000 people develop an HPV–related form of cancer annually, with a 50% mortality rate. The current vaccination rate needs to be maintained and improved, and distributed globally, as the proportion of herd immunity needed to stop the spread of infection is not yet understood. On–going trials aim to develop further immunotherapies, protecting both men and women. (*The Guardian*, 4 June 2013)

▸▸ An Australian bill to guarantee public access to patented drugs, vaccines and genetic tests, and to allow Australia to export cheaper and generic versions of vital drugs passed its first parliamentary hurdle. The bill attracted some criticism for being inconsistent with Australia's free–trade agreement with the USA, and for contradicting a World Trade Organisation (WTO) agreement that drugs can only be exported to WTO–member countries. In reply, Australia's Parliamentary Secretary for Innovation, Ms Yvette D'Ath, stated that "arguably, non–WTO members are the countries that need our help the most." (*Sydney Morning Post*, 26 June 2013)

China

▸▸ Chinese life expectancy at birth increased from 69.3 years to 75.7 years between 1990 and 2010, largely due to decreasing child mortality and lower rates of tuberculosis and lower respiratory infections. Child mortality fell by 6% per annum, mainly due to massive reductions in childhood respiratory infections and diarrhoea. This gives China the lowest rate of premature mortality amongst the developing countries, and a rate only marginally higher than the USA. However, this is partially offset by growing concerns over the rise of western–style diseases in China, with increasing non–communicable diseases (eg, dementia), driven by urbanisation and an ageing population, plus lifestyle diseases (eg, type 2 diabetes, lung cancer). There are calls for more aggressive tobacco control to help address these emerging problems. (*Medical News Today*, 8 Jun 2013)

▸▸ The rapid pace of growth in the Chinese economy is associated with an exponential increase in China's aid to developing countries over the last decade. By 2009, China provided US$ 1.4 billion in aid, including at least 49 African countries, making it an emerging strong player in global health. Its development approach introduces qualitative changes to the cost–effectiveness focus of western frameworks, moving towards more solidarity and mutual benefit approaches in this so called 'south–south' co–operation. While helping others, China will also need to deal with its own troubling double burden of disease, the large internal market for counterfeit medicines and concerns about transparency and human rights in its policies. The post–2015 development agenda will become a critical period for Chinese involvement in global health. (*The Guardian*, 10 Jun 2013)

▸▸ The British pharmaceutical company GSK recently sacked the head of the Research and Development department of its Chinese branch. A Chinese neurologist was dismissed after a study he co–authored and published in *Nature* in 2010 contained misrepresented data. The study aimed to elucidate the role of the protein interleukin–7 in autoimmune diseases. The authors used blood samples from healthy subjects, but reported them as belonging to patients with multiple sclerosis, thus skewing the results. Afterwards, another author resigned and three were placed on administrative leave. Trials of an experimental multiple sclerosis drug informed by the study's results have been suspended as a safety measure. (*Reuters,* 11 June 2013)

▸▸ China's Health Ministry announced plans to monitor and evaluate the long–term impact of chronic air pollution on human health. It will gather data on particulate matter with a diameter of 2.5 μm (PM2.5) in different locations. It will uncover linkages between air pollution and health, initially focusing on cities where pollution is most prevalent. It will analyse PM2.5 data, weather information and local disease and death. It is estimated that poor air quality can shorten peoples' lives by 5.5 years, and air pollution and quality are of growing concern to China's increasingly urbanised population. Recently, PM2.5 levels reached 1000 in some parts of Harbin, a city of 11 million people, and

brought the city to a virtual standstill. A level above 300 is hazardous, and WHO recommends a limit of 20. (*Reuters*, 28 Oct 2013)

In November 2013, Mr Xi Jinping, China's party chief and state president, convened the five–yearly plenary meeting of the 11th central committee. It is hoped that Mr Xi will use the meeting to drive changes in state–owned enterprises and in the countryside, where farmers still lack clear rights to their land – in stark contrast to city–dwellers' property rights. Reforms would boost China's trajectory from an investment–heavy economy, supported by cheap labour, to a mature model based on consumption and high wages. (*The Economist*, 2 Nov 2013)

Europe

Bernia Hamidović was a three–month–old baby who died after her lack of an ID number prevented her treatment for a tracheoesophageal fistula. Her parents tried to take her across the border to Belgrade for treatment, after treatment in Sarajevo failed. She did not have a passport or medical card, as the parliamentary failures to define Bosnian regions (determining ID numbers) means that children born after February 2013 cannot be registered. The debate is sparked by a push to recognise the geographical split between the Serb majority region and Croat–Bosniak majority region. Although Bernia was allowed to travel to Belgrade, she was refused treatment as funding was denied. She died from infection before Serbian doctors could carry out treatment. (*Fox News*, 17 Jun 2013)

Across Europe, over 50% of people are overweight or obese and non–communicable diseases cause 77% of the disease burden. At the WHO's European Ministerial Conference of Health 2020, ministers of health pledged to reduce obesity and promote health. They pledged to improve monitoring of the impact of the problem, and to more effectively address the root causes of obesity. Possible actions include: restricting the marketing of junk food to children; ensuring that the food industry does more to tackle health problems; more intensive monitoring of key issues; and supporting healthier food choices. (*WHO Europe,* 5 July 2013)

The European Respiratory Society evaluated the European disease burden from respiratory conditions, using data from WHO and the European Centre for Disease Prevention and Control. It found that deaths from diseases such as lower respiratory tract infections, lung cancers, tuberculosis and Chronic Obstructive Pulmonary Disease account for 10% of deaths across Europe. Mortality from these diseases is highest in the UK and Ireland, whereas Finland and Sweden have the lowest rates. Smoking is the largest preventable cause of these illnesses. "Both the prevention and treatment of lung diseases will need to be improved if their impact on longevity, quality of life of individuals and economic burden on society are to be reduced in Europe and worldwide," said the president of the European Respiratory Society, Prof Francesco Blasi. (*BBC News*, 6 Sept 2013)

The European Parliament rejected proposals to regulate e–cigarettes as medicine, which could have restricted their availability and their up–take by smokers. E–cigarettes contain a liquid nicotine solution that is inhaled without burning tobacco and its associated carcinogenic side–effects. Some analysts expect e–cigarettes to supplant traditional cigarettes. They will still be subject to the same marketing restrictions as tobacco. At the same time, the Parliament voted to increase the size of warning labels on cigarette packets, and approved a ban on menthol and other flavoured cigarettes designed to appeal to youngsters. (*Financial Times*, 8 Oct 2013)

A UK Government report shows that UK child mortality rates are amongst the worst in Europe, worsening over the past 15 years. This translates into an additional 2000 children dying each year in the UK, compared to other Western European countries. Wide variations in care and in the management of common conditions were highlighted. Underlying problems may be exacerbated by the UK's high rates of relative poverty, with its implications for health outcomes. As well as moral and social imperatives, there are economic arguments for investing in children's health, as poor health in childhood can store up future problems. (*The Guardian*, 30 Oct 2013)

India

India's leading drug company, Sun Pharmaceutical Industries, is in talks with the Swedish drug–manufacturer Meda AB to buy a controlling stake for US$ 5–6 billion, primarily to boost its generics business in developed markets. With the same focus as Sun Pharma, Meda is involved in speciality products, over–the–counter drugs and branded generics, and had sales of US$ 1.98 billion in 2012. Sun Pharma has made several acquisitions in recent years, but this would be its biggest so far. Last year, it bought US–based Dusa Pharmaceuticals Inc. for US$ 230 million, and URL Pharma from

Japan's Takeda Pharmaceutical Co for an undisclosed amount. Buying Meda gives Sun Pharma access to Dymista, an allergy medicine with high market potential, which received US approval in 2012. (*Reuters*, 31 May 2013)

▸▸ Research published in *The Lancet* suggests that 45% of deaths in children under five are caused by malnutrition. A review of maternal and child under–nutrition and obesity in low– and middle–income countries, including a progress review for nutrition programmes, was led by Prof. Robert Black from Johns Hopkins Bloomberg School of Public Health in Baltimore, USA. Despite progress, 165 million children are affected by stunting and 50 million by wasting (low weight for height) in 2011, with India being the largest single contributor. An estimated 900 000 lives could be saved in 34 countries if 10 proven nutritional interventions were scaled–up to 90% of the world. The researchers warn that countries will not break out of poverty unless nutrition becomes a global priority. "If maternal and child nutrition can be optimised, the benefits will accrue and extend over generations, which is why we must work together now to seize this opportunity," said Dr Richard Horton, Editor–in–Chief of *The Lancet*. (*The Lancet*, 3 Aug 2013)

▸▸ India's cheap food scheme, which aims to reach 800 million people, was enshrined in law in August 2013. Its strengths include ensuring children have a daily hot lunch and promoting better nutritional advice and health–care for under–sixes. Critics say that it does not address the huge problem of food storage and waste in India, and is not effectively targeted at the 20 million people who most need help. More emphasis is needed on better nutrition, as undernourishment is common even where food supplies are adequate. Roughly half of children under five are undernourished, and 60 million are stunted, and face brain damage, reduced capacity to learn and higher mortality. There are calls for more spending on public health and better sanitation, as infections from polluted water affect peoples' ability to absorb nutrients. (*The Economist*, 24 Aug 2013)

▸▸ Pathfinder International, which aims to expand access to quality sexual and reproductive health care, announced a new partnership with the state government in Haryana, India. Pathfinder will provide technical support and guidance, drawing on its history of working to improve sexual and reproductive health in India. A large part will focus on changing traditional patterns of behaviour, such as delaying ages of marriage and first pregnancy, and spacing births. The project will sensitize men and religious leaders in the community to the importance of equality and the healthy timing and spacing of pregnancy. Pathfinder will provide support for capacity building and supportive supervision of frontline health workers to help streamline the contraceptive supply chain system to better serve communities. (*Pathfinder*, 30 Sept 2013)

▸▸ The annual Global Hand–washing Day on 15 October was organised by the Global Public–Private Partnership for Hand–washing with Soap. It supports the universal promotion and practice of proper hand–washing with soap at critical times. This stops the transmission of disease agents and can significantly reduce diarrhoea and respiratory infections, and may impact on skin and eye infections. It is an extremely effective and inexpensive way to prevent infections responsible for millions of child deaths, with India being the country where the largest number of related child deaths occurs. Turning the simple steps of hand–washing with soap before eating and after using the toilet into ingrained habits could help towards meeting the Millennium Development Goal of reducing deaths amongst children under the age of by two–thirds by 2015. (*Partnership for Handwashing*, 15 Oct 2013)

The Americas

▸▸ In the wake of the devastating earthquake in 2010 which killed over 200 000 people and displaced over one million people, there has been the worst cholera outbreak in recent history, and has claimed 8000 lives to date. The rapid and focused response has averted more casualties and the case–fatality rate has dropped below the WHO standard of 1%. However, Haiti will probably have on–going problems with cholera infections. It is vital that these are addressed by investing in Haiti's water and sanitation infrastructures. To achieve this, the Pan–American Health Organisation, the US Centers for Diseases Control and Prevention and UNICEF have joined with the governments of Haiti and the Dominican Republic to develop plans for cholera elimination. The US$ 2.2 billion programme will focus on improving water, sanitation and hygiene conditions that are the main vector for cholera infections. (*PAHO*, 9 Oct 2013)

▸▸ A letter to President Obama calls for an end to the US embargo against Cuba. It arose from a critical care conference held in Havana, which focused on the embargo's devastating effects on Cuban health. The embargo prohibits US companies from selling medical supplies to Cuba, and prevents foreign companies from trading with the US if they do business with Cuba. At the conference, Jorge Soberon of the Cuban Health Ministry, reported that this pre-

vented Cuba from accepting US$ 4 million from France to tackle AIDS and tuberculosis, and led to problems in treating children with diseases such as leukaemia and diarrhoea. Doctors from 18 countries, including the USA, attended the conference, and called the embargo a "humanitarian catastrophe." (*BMJ*, 29 Oct 2013)

▸▸ Three projects were honoured at the annual Malaria Day as "malaria champions of the Americas", which integrate malaria interventions with solutions for other health problems. In the Americas, nearly 106 million people live in areas at high risk of malaria, although the number of cases fell by 60% from 2000 to 2012, and the number of deaths fell by 70%. The main award went to the Colombia Malaria Project, whose achievements include creating sustainable local capacity through training local health workers in malaria prevention and control, and improving the well–being of indigenous communities. The National Centre for Control of Tropical Diseases in the Dominican Republic was recognized for its innovative use of technology in addressing each malaria case individually, and collaborations with other agencies. The Secretariat of Health of the State of Acre, Brazil was recognised for leadership in reducing malaria, and its efforts to address other health problems. (*PAHO*, 7 Nov 2013)

▸▸ According to the recent Pan–American Health Organisation (PAHO) recent report on human resources in health, about 70% of countries in the Americas have sufficient (or even more) doctors, nurses and midwives to provide basic health care services for their populations, with ratios at or above WHO/PAHO recommendations. However, many countries face challenges in the distribution, training and migration of workers. Healthcare workers are often concentrated in urban areas at the expense of inaccessible and sparsely populated areas. Some countries face high rates of outward migration of health care workers, leading to shortages, so improving workers' employment is important. Looking to the future, training must be aligned with changing health needs, and focus on health care access, equity and quality. (*PAHO*, 11 Nov 2013)

▸▸ As OECD research shows that young people in the USA's workforce have the lowest levels of maths skills in the developed world, a new experiment is under way in raising the educational attainment of the poorest children in the USA. Poor children's attainment lags behind their wealthier peers at the start of school, and the gap persists throughout the child's education. Prof Greg Duncan, a US economist, will take a randomized group of low–income single mothers, and give each US$ 4000 for the first three years of the children's lives. A control group will get smaller amounts. The research aims to establish if there is a direct link between poverty reduction and cognitive development, and if children's school performances improve as a result. Improving educational performance is the key to boosting the US's low social mobility rate. (*BBC News*, 13 Nov 2013)

The Bill and Melinda Gates Foundation

Bill Gates clashed with Dambisa Moyo, a prestigious Zambian economist over the value of development aid in tackling poverty. In her book "Dead Aid", Ms Moyo argues that aid has actually increased poverty, corruption and dependency in Africa, while Mr Gates has commented that books like hers are "promoting evil". The clash has been prominent over Twitter, mostly light–heartedly. The complex aid debate continues on and is becoming increasingly polarised, highlighting an apparent difficulty in quantifying impact of aid provisions. (*The Guardian,* 31 May 2013)

The European Commissioner for Research and Innovation signed an agreement with the Bill and Melinda Gates Foundation, with both parties pledging to fund research into drugs, vaccines and diagnostics to combat HIV, tuberculosis, malaria and other neglected infectious diseases. Currently, these poverty–related diseases affect more than one billion people worldwide, many of whom are living in developing countries where there is little or no access to safe and affordable treatment. Despite cuts in other areas of the EU budget, the Commissioner's research and innovation directorate budget has remained intact; and this agreement is part of the EU Horizon 2020 programme. It is anticipated that it will allow the development of at least one new and better health product per year. Mr Gates described the partnership as "critical to the success of our common mission…we can together improve the lives of millions." (*EUACTIV,* 10 June 2013)

The Foundation announced its latest Grand Challenges Explorations, a programme to encourage bold approaches to improving the lives of the world's poorest people. Grant in the amount of US$ 100 000 are available for new ideas on: how to encourage the world's poorest people to seek health care; developing a new condom; and reducing diarrhoea, one of the world's biggest killers of children. Projects demonstrating potential could receive additional funding up to US$ 1 million. The simple online application is open to anyone from any discipline (including cross–disciplinary applications) or organisation. Since its launch in 2008, it has funded more than 850 grants in 50 countries. (*BMGF*, 5 Sept 2013)

The Brazilian health minister announced a partnership between Bio–Manguinhos (Brazil's leading medical research facility) and the Bill and Melinda Gates Foundation to develop and export an affordable combined measles and rubella vaccine to low income countries. Measles is a leading cause of children under five in these countries, and rubella has serious consequences for pregnant women and their babies. Brazil follows in the footsteps of China and India, whereby major emerging markets develop low–cost drugs for lower–income nations. The combined vaccine currently has limited availability, and Bio–Manguinhos will increase availability by 30 million doses annually, at much lower costs than present. The Gates Foundation has granted US$ 1.1 million to support clinical trials and the vaccine is expected to reach the market by 2017. (*Reuters*, 28 Oct 2013)

The Foundation announced a new initiative to develop vaccines to tackle child mortality in the developing world, where preventable diseases such as malaria and pneumonia are a leading cause of death. This scheme, known as the Vaccine Discovery Partnership, will see the Foundation working alongside pharmaceutical companies. Sanofi and GlaxoSmithKline (GSK) are the first to sign up, and it is hoped that others will soon follow. A project with GSK is already under way, on building thermostability into vaccines to enable their safer delivery in countries with limited resources. By working with pharmaceutical companies the Foundation hopes to reduce the costs and risks associated with early–stage vaccine research, saying that "this will be a win for everyone involved but most importantly for the children around the world who will get the life–saving vaccines they need." (*BMGF*, 29 Oct 2013)

The GAVI Alliance

The non–profit International Medica Foundation has developed the first rotavirus vaccine suitable for newborn babies. The vaccine–preventable rotavirus can cause life–threatening diarrhoea. In developing countries, it is more common amongst babies and younger children compared to developed countries. In China alone, it causes 4900 deaths and 329 000 hospitalisations of children and infants, causing more than half a million deaths worldwide. Existing rotavirus vaccinations are expensive to produce, transport and store, carry higher risks of intestinal blockages, and are unsuitable for newborn babies. The new vaccination overcomes these problems, and is suitable for global use. They have been sub–licensed to Shanghai BravoBio Co. Ltd of China, a private biotechnology company

based in Shanghai, for use in China. The Foundation is now seeking more private sector partners to extend global coverage. (*WSJ*, 27 Jun 2013)

▸▸ A major initiative to eliminate measles outbreaks in the DR Congo started in September 2013. The aim is to vaccinate 6.8 million children aged from six months to nine years in two of the country's provinces, and to give two drops of polio vaccine to children under five. This will be rolled out to other parts of the country by 2014. Thanks to concerted efforts, polio has not occurred in the country since December 2011, but measles outbreaks continue and are a leading cause of childhood deaths despite the existence of effective vaccinations. As measles spreads very readily, high rates of coverage are needed to provide protection. Ongoing measles outbreaks show that routine vaccination coverage in the DR Congo is too low. (*GAVI Alliance*, 24 Sept 2013)

▸▸ GAVI is on track to meet its ambitious targets of supporting developing countries to immunise an additional quarter of a billion children by 2015, thus preventing nearly four million deaths. Its report found that the gap in access to immunisation between low– and high–income countries is closing, and that GAVI is on target to help avert nearly four million future deaths. GAVI has made significant progress towards achieving its four strategic goals of: accelerating the uptake of under–used and new vaccines; strengthening health systems to improve coverage; improving long–term predictability and stability of financing; and helping to improve vaccine market conditions for developing countries. "Vaccines are already widely recognised as one of the most cost–effective public health tools, but we cannot rest until all children, regardless of where they live, have access to the best possible protection against vaccine–preventable diseases," says Dr Seth Berkley, CEO. (*GAVI Alliance*, 14 Oct 2013)

▸▸ An advisory group to the Indian government approved the national scale–up of the pentavalent vaccine. The extension will be accompanied by careful monitoring for any adverse reactions to the vaccine. The "five–in–one" pentavalent vaccine combines vaccinations for diphtheria, tetanus, whooping cough, hepatitis B and *Haemophilus influenza* type b (Hib, causing meningitis, pneumonia and otitis). It will reduce the number of injections needed from nine to three. Globally, Hib is the second most common cause of bacterial pneumonia deaths, and the third biggest vaccine–preventable death in children aged under five. Each year, it causes eight million serious illnesses, and claims 400 000 lives. In welcoming India's decision, the GAVI Alliance said that it could save one million lives by 2020. (*GAVI Alliance*, 30 Oct 2013)

▸▸ Globally, pneumonia remains the single biggest killer of children aged under five, with over a million deaths each year. There is a range of tools against pneumonia, making it a highly preventable disease. To deal with the challenge, the GAVI Alliance will support the introduction of pneumococcal vaccine across 50 countries by 2015. "The GAVI Alliance is helping to accelerate the fight against pneumonia by increasing access to pneumococcal vaccines, thanks to GAVI's innovative Advance Market Commitment, but also to the five–in–one pentavalent vaccine which protects against Haemophilus influenza type b, another major cause of pneumonia," said Mr Seth Berkley, CEO. (*GAVI Alliance*, 12 Nov 2013)

▸ The World Bank

▸▸ Jim Yong Kim, President of the World Bank, has called for a global 'science of delivery' to ensure that development aid is delivered consistently and its benefits are widespread. He believes that a systematic approach would greatly improve outcomes, and the four main components of this new science would be: knowledge collection to support frontline implementation, teaching of delivery skills based on the experience of the most successful practitioners, incorporation of research to encourage innovation and development of frameworks to adapt and explain successful solutions to delivery problems. (*McKinsey on Society*, 28 Apr 2013)

▸▸ The World Bank's *Doing Business* annual survey measures the costs to companies of business regulations in each of the 183 countries surveyed. By supporting transparency and spurring improvements in business environments, it aims to promote private sector development and wealth creation within each country – crucially important to developing countries. It is also one of the lending criteria for low–income countries. Yet there is controversy over the Bank's methodology and its focus on de–regulation. There are real concerns that some countries try to improve their rankings by diluting vital safety and environmental protection legislation. This criticism has come from some developing countries (including China), aid agencies and trade unions. This prompted a review of the report in June 2013, which recommends overhauling the indicators, and reviewing its economic rationale to ensure fairness. (*The Guardian*, 31 May 2013)

▸▸ At the London Nutrition for Growth Summit in June 2013, global leaders committed to giving Ł 3 billion in fund-

ing to tackle the problem of malnutrition in the world's poorest countries. The summit was primarily supported by The Children's Investment Fund Foundation and consisted of both private and public sector agencies, including the World Bank. Research by Save the Children identifies lack of nutrients in the first 1000 days of life as a major risk factor for learning difficulties, greatly stunting economic and social development within emerging countries. The charity's chief executive Justin Forsyth highlighted the importance of the summit in recognising this significant danger of malnutrition and urges them to "commit to tackle its scourge for good." This increase in funding is therefore an impressive start to the G8 period. (*Financial Times,* 8 Jun 2013)

▸▸ Cash transfers are increasingly used to alleviate poverty and support development in emerging economies. The idea is simple: instead of spending cash on schools and infrastructure, individuals or businesses directly receive a fixed cash amount. There are two types of transfer: conditional (CCT) and unconditional (UCT). UCT recipients chose how to use the money, and CCT recipients have conditions attached, eg, school attendance, vaccinations or business planning. The World Bank's assessment shows that both are highly effective in pulling people out of poverty. Most UCT recipients spent the money on projects that raise their income. They are invaluable when the main cause of poverty is shortage of capital and are very cost–effective. But by attaching conditions such as school or clinic attendance, CCT is better for long–term development where complex factors (eg, low literacy levels, poor child health and nutrition) keep people in poverty over time. (*The Economist*, 26 Oct 2013)

▸▸ The Zambian Minister for Tourism and Arts, Ms Sylvia Masebo, launched the World Bank *Tourism in Africa* report. It provides strategies to maximise the economic power of tourism, in order to boost growth and improve livelihoods. In 2012, sub–Saharan Africa attracted 33.8 million visitors, compared to 6.7 million in 1990. Income from tourism amounted to US$ 36 billion, contributing 2.8% to the region's GDP and creating 5.5 million direct jobs. The report notes that there is huge untapped potential for tourism in sub–Saharan Africa, which has expansive beaches, plentiful wildlife, and nature, culture and adventure opportunities. Domestic tourism is also expected to increase as disposable incomes rise. (*World Bank*, 13 Nov 2013)

United Nations (UN)

▸▸ Between 1990 and 2010, the proportion of the world's population living on less than US$ 1.25 a day (ie, extreme poverty) halved to 21%, or 1.2 billion people. This means that the Millennium Development Goal (MDG) of halving poverty rates by 2015 has already been met. This success has led to commitments to eradicating extreme poverty by 2030, endorsed by President Barack Obama. The British Prime Minister, David Cameron, chaired a UN panel that set out a blueprint for eradicate extreme poverty, and proposals to improve access to food and water, better governance, boosting jobs and economic growth, and strengthening human rights. It states the role of climate change in meeting this goal, as it affects poorer people disproportionately. Whilst welcoming the "zero goal" of ending extreme poverty, some aid agencies called for more emphasis on reducing inequalities, which are not specifically addressed in the report. (*The Guardian*, 30 May 2013)

▸▸ UN Secretary General Ban Ki–moon appealed to philanthropists to "make a smart investment in the world's future" by joining UN efforts to accelerate the fight against five of the most deadly infectious diseases (malaria, polio, tetanus, measles and HIV) which kill millions every year. Significant progress has been made in fighting these diseases, and Mr Ki–moon declared that it is possible to eliminate them within five years. He called on the private sector and philanthropists to join the fight, saying that every US$ 1 invested in fighting malaria in Africa, US$ 40 is generated in gross domestic product, strengthening economies and peoples' livelihoods. (*UN News*, 5 Jun 2013)

▸▸ The UN World Investment Report 2013 reveals that foreign direct investment (FDI) inflows to the world's least developed countries rose by 20% in 2012, reaching a record US$ 26 billion. For the first time, least developed countries overtook developed countries as the main FDI recipients. The increase was led by Cambodia, the Democratic Republic of the Congo, Liberia, Mauritiana, Mozambique, Liberia and Uganda. More of this investment originated in developing countries themselves, notably India, which invested in diverse projects across Africa and Asia. The UN Secretary General, Mr Ban Ki–moon, called this a "source of reflection and inspiration." He re–iterated the linkages between FDI and development. (*UN News Centre*, 27 Jun 2013)

▸▸ In September the UN launched an aid appeal to support farmers and herders in the Sahel region of Africa. Stretching from the Red Sea to the Atlantic Ocean, encompassing areas between the Sahara desert in the north and the Sudanese savannah to the south, Sahel suffers from political instabilities, security issues and human rights violations. These factors, combined with increasing grain prices due

to the 2012 drought, have left 11 million people at risk of hunger. Mr Robert Piper, the region's UN Regional Humanitarian Coordinator, asked the UN for US$ 1.7 billion, but only 36% of it has been received. The appeal has been re–launched to attempt to secure funding ahead of the next agricultural season. (*UN News Centre*, 4 Sep 2013)

▸▸ The IMF announced a reduction in its forecasts for global economic growth for 2013 and 2014. The revised figure shows an expected global growth rate of 2.9% for 2013 (down by 0.3%), and 3.6% for 2014 (down by 0.2%). The main reasons are weakness in emerging economies, despite relatively strong growth in developed economies such as the USA and UK, and stabilisation in the Eurozone. Slower rates of economic growth in countries such as Brazil, China and India are holding back global economic growth. This is partly caused by the impact of the US debt crisis, and fears that it could reduce economic stimulation measures as a result. These fears have already affected interest rates and the cost of borrowing in emerging economies, thus dampened their growth prospects with knock–on effects on poverty reduction. (*BBC News*, 8 Oct 2013)

UN AIDS and The Global Health

▸▸ The UN AIDS Update on Africa charts the African AIDS response. It shows a huge increase in the number of people receiving antiretroviral treatment for HIV, from less than 1 million in 2005 to 7.1 million in 2012. Sixteen African countries are ensuring that at least 75% of pregnant women living with HIV receive antiretroviral treatment, lessening transmissions to babies. This has led to a 32% drop in AIDS–related deaths between 2005 and 2011. However, Africa remains the continent most affected by HIV. In 2011 there were 1.8 million new HIV infections, and 1.2 million people died of AIDS–related illnesses. (*UN News Centre*, 21 May 2013)

▸▸ With more than 34 million people infected, HIV is a major contributor to the disease burden in many countries. Globally, the management, control and policy of this epidemic are instrumental in reshaping conventional wisdom in public health, research and practice. Through innovative approaches to prevention and treatment programmes, it has influenced cultural attitudes and social behaviours, and bridged traditional boundaries between public health and clinical medicine. With its human rights approach to health, HIV/AIDS has addressed crucial issues on the right to treatment, and affordable access to vital medicines. HIV/AIDS has attracted private philanthropy such as the Bill and Melinda Gates Foundation, leading to new models of public health practice through Public–Private Partnerships, funding scientific investigations, global health initiatives, and building crucial health care delivery infrastructure in developing countries. Thus, HIV/AIDS has replaced traditional approaches of "international health" by inventing innovative approaches to "global health". (*New England Journal of Medicine*, 6 Jun 2013)

▸▸ On 20 June 2013, the US Supreme Court struck down section 7631(f) of the Leadership Act. This section meant that no funds made available under the Leadership Act may "provide assistance to any group or organisation that does not have a policy explicitly opposing prostitution and sex trafficking." The Court held that the provision violated the First Amendment of the US Constitution which protects free speech. It means that AIDS groups can work more effectively with sex workers, who have much higher risks of HIV infection than the general population. The USA is a major sponsor in the fight against HIV and AIDS, so this greatly strengthens the global HIV response. (*UN AIDS*, 21 Jun 2013)

▸▸ WHO recommends widespread circumcision as an effective additional intervention in regions with HIV epidemics. It may reduce the risk of heterosexual male infection by approximately 60%, and the WHO has a target of 20 million circumcisions in Africa by 2015. It approved the use of a circumcision device, PrePex™ that incorporates a band that puts pressure around the foreskin, causing tissue death and circumcision. The device paves the way for more non–surgical circumcisions, which is potentially safer, simpler and cheaper. However, circumcision does not eliminate HIV infection or prevent transmission, so wider measures (eg, condom usage) are still crucial. (*WHO*, 31 October 2013)

▸▸ New figures from UN AIDS reveals that out of a total of 35.3 million people living with HIV, an estimated 3.6 million are aged 50 years or over. The majority of these are in low and middle income countries. UN AIDS is concerned that this group's specific health needs are being missed, leading to lives being lost. This "aging" is due to the success of antiretroviral treatments. UN AIDS highlight that HIV prevention and testing needs to be tailored to the needs of this group, the importance of timely drug therapy as the immune system weakens over time, and integrating HIV services into other health screening services aimed at this age group. (*UN AIDS*, 1 Nov 2013)

UNICEF

Some of the world's poorest countries have cut maternal and child mortality rates by 50% or more since 2000, according to the UNICEF report *Accounting for Maternal, Newborn and Child Survival,* although progress has been lagging in others. The report assesses progress in the 75 countries that account for more than 95% of all maternal and child deaths. Rwanda, Botswana, and Cambodia have made notable progress in reducing mortality since 2000. The key findings are: a significant drop from 543 000 in 1990 to 287 000 in the number of women dying each year from pregnancy– or childbirth–related complications; and deaths among children under five years dropped from 12 million in 1990 to 6.9 million in 2011. (*UNICEF*, 27 May 2013)

A Save the Children Report states that childhood under–nutrition could have considerable effects on literacy and learning, with serious implications for later life. A new study interviewed and tested over 7000 children at key points in their lives, and showed that malnutrition in early life is associated with poorer educational performance, with undernourished children performing worse in mathematics, reading and writing tests and being 19% less likely to be able to read a simple sentence when aged eight. The scale of this problem is potentially enormous; currently one in four of all children under 5 are stunted due to under–nutrition. The research was backed publicly by a group of children's authors, who are calling on G8 Governments to increase their response to tackle hunger worldwide. (*Save the Children*, 27 May 2013)

With the fresh challenges of the post–2015 era fast approaching, the deficit of data in global health research must be urgently addressed. This "data revolution" is vital in addressing the problems of marginalised groups to "leave no one behind," one of the key promises in the UN High–Level Panel Report on Eminent Persons. The report criticises the Millennium Development Goals for insufficiently focusing on the most excluded people, particularly those living with disabilities, or outside traditional household units. Despite the emergence of new technology for data collection, the household survey is recommended as an efficient, cheap and comprehensive method for broadening coverage and collecting better information about groups particularly affected by social inequality. Household surveys ensure that measurements and monitoring of groups previously sidelined in data collection are integrated into well–established survey systems. (*The Guardian,* 10 Jun 2013)

UNICEF published its annual assessment of developing and strengthening supply chains, which improves access to life–saving supplies for children and their families. Optimising UNICEF's supply chains supports the realisation of children's rights to health, education, nutrition and protection, and ensures that UNICEF's programmes have a higher impact. The recent implementation of changes to its supply planning and accountancy systems have led to savings of 4% in supplies procured. UNICEF reported that the new systems also have clear advantages in terms of efficiency, visibility and oversight. These gains will become more evident as the new systems and techniques stabilise and mature. (*UNICEF*, 30 Jun 2013)

UNICEF reinforced its commitment to transparency and accountability by publishing its Information Disclosure Policy. It outlines UNICEF's commitment to sharing information on its programmes and operations with everyone. From September 2012 onwards, UNICEF also had full public disclosure of all its internal audit reports, and annual programme reports. As a signatory to the International Aid Transparency Initiative, UNICEF will publically disclose information on aid spending. This ensures that users can easily find, use and compare data. Information will be available in user–friendly formats. Ultimately, information disclosure makes agencies more efficient, responsible, collaborative and better able to deliver their goals. (*UNICEF*, 24 Oct 2013)

World Health Organization (WHO)

The world is unprepared for a massive virus outbreak, warned Dr Keiji Fukuda of the WHO, amid fears that the H7N9 bird flu virus striking China could mutate into a form that spreads easily amongst people. According to the latest data, 135 people in China have been infected, including 44 deaths. It is one of an array of avian flu viruses, most of which pose little or no risk to humans. The more common strain of avian flu, H5N1, has killed more than 360 people globally. The year 2003 saw the emergence of the SARS virus and the re–emergence of the H5N1 virus. WHO acknowledged that any new virus that infects humans could become a global health threat. Rapid–reaction sys-

tems are crucial, as health authorities are hampered by lack of knowledge about such diseases, and how it can spread amongst people. (*AFP*, 21 May 2013)

▸▸ The 66th World Health Assembly (WHA) concluded with agreement on a range of new public health measures and recommendations aimed at securing greater health benefits for all people, everywhere. During her closing address, the WHO Director–General Dr Margaret Chan issued a warned over the novel coronavirus, citing lack of understanding and its threat to the entire world. WHO has already recognized that coronavirus is an important and major challenge for all affected countries, as well as the rest of the world. It calls for understanding how people are getting infected, and identifying the main risk factors for either infection or development of severe disease, as a matter of urgency. (*WHO*, 27 May 2013)

▸▸ Current models for developing new medical and pharmaceutical products are under review, and new models are needed to meet changing market requirements in developing and developed countries. This theme was addressed at the joint symposia on changing business models between the WHO, World Trade Organisation and World Intellectual Property Organisation. Participants included GAVI Alliance, South African Medical Research Council, and the Bill and Melinda Gates Foundation. The WHO, WIPO and WTO are also expanding their capacities on the interface between intellectual property, trade and public health by strengthening their collaboration. This is part of wider efforts to improve access to medicines by the world's poor, including new and more effective medicines. (*WTO*, 30 Jul 2013)

▸▸ The WHO report on global tuberculosis (TB) control reveals that in 2012, the number of people with TB fell to 8.6 million people, and deaths to 1.3 million, with treatment saving 22 million lives. The world is on track to meet the Millennium Development Goal of a 50% reduction in the mortality rate by 2015, and reversing TB incidence. To keep up this momentum, WHO highlighted that more must be done to reach the 3 million TB patients "missed" by health systems, and for faster responses to drug–resistant TB. More funding is essential to meeting the challenges in scaling–up screening and access to treatment. (*WHO*, 23 Oct 2013)

▸▸ In October 2013, the WHO published its annual World Health Statistics, which reports progress toward the Millennium Development Goals. Recently, progress has accelerated in many countries, but large gaps remain both between and within countries. Twenty seven countries have met the MDG target of a two–thirds reduction in under–five mortality rates. However, the overall rate of decline is not enough to meet this target globally by 2015. Under–nutrition is the underlying cause of death in 35% of cases. The decline is under–nutrition is on track to meet the MDG, but wide variations persist. There has been a substantial reduction in global maternal mortality rates, but the rate of decline needs to double if the target is to be met. The MDG of halving the proportion of the world's population without access to safe drinking water was reached in 2010, although some regions will miss this target and there are sharp discrepancies in access between richer and poorer households. Progress is slower towards the sanitation goal, with more than 2.5 billion people worldwide lacking access to better sanitation. Access to medicines is still problematic in low and middle–income countries, with an average of only 57% of generic medicines being readily accessible through the public sector. (*WHO*, 31 Oct 2013)

Demography

In 2008, for the first time, half the world's population lived in cities. Studies show that 25% of the world's population live in 600 cities that generate up to 60% of global output. In 1975, there were just three megacities (New York, Mexico City and Tokyo), with populations of over 10 million. Today, there are at least 20. Many of the world's biggest cities are vulnerable to natural disasters eg, flooding and earthquakes. Their rapid growth in developing countries means that many of their citizens live in vast slums. By 2025, it is estimated that only four megacities will be in Europe or North America – the remainder will be in Africa, Asia and Latin America. City governments are often weak, with limited clout to deal with their problems. "These megacities are a big part of humanity's future. The prospect should be both exhilarating and terrifying – and a call to action for better urban policies," says Harvard University's Edward Glaesar, author of *Triumph of the City*. (*Financial Times*, 1 Feb 2013)

The 50th anniversary of the African Union's (AU) establishment in 1963 is an opportunity to review its strengths, weaknesses, and achievements. Its mission is to promote pan–African political self–determination, economic self–reliance and solidarity. It was steadfast against white minority rule and colonialism, launching Africa's path to decolonisation and majority rule. This culminated in the peaceful dismantling of apartheid in South Africa in 1994. It has mediated in border disputes to resolve conflicts – a major cause of interstate conflict. However, the AU has been less likely to intervene in state–sponsored terrorism and heinous crimes, including ethnic cleansing and genocide. Today, the AU is lauded for deploying peace–keeping forces, and playing a greater role in resolving internal conflicts. Its Regional Economic Communities lead peace–keeping initiatives, and promote economic co–operation and integration. It is hampered by a lack of resources, and is heavily dependent on external funding. This raises questions about African ownership. Its internal structures risk spreading its influence too thinly, and it is criticised for its membership, which includes countries with poor human rights records and electoral fraud. (*The Guardian*, 21 May 2013)

A UN report predicts that the world population will rise from the current figure of 7.2 billion to 9.6 billion in 2050. It states that the population in developed countries should remain static, whilst the birth rates in developing countries are predicted to soar. The Director of the Population Division in the UN's Department of Economic and Social Affairs, Mr John Wilmoth, said that "rapid growth is expected to continue over the next few decades in countries with high levels of fertility such as Nigeria, Niger, the Democratic Republic of the Congo, Ethiopia and Uganda but also Afghanistan and Timor–Leste, where there are more than five children per woman." The report analysed demographic data from 233 countries. It also predicted an increase in life expectancy, with people living up to 89 years in developed countries, and up to 81 years in developing countries by 2100. (*UN News*, 13 Jun 2013)

The UN High Commissioner for Refugees gave a stark warning that the world has the worst refugee crisis since the Rwandan genocide of 1994. Its global trends report stated that more than 45.2 million people were displaced in 2012. This includes 15.4 million refugees (fleeing from their own country to another), 937 000 asylum seekers and 28.8 million internally displaced people (ie, seeking refuge within their own country). The main drivers are the wars in Syria, the Democratic Republic of Congo and Mali. Accommodating refugees places huge pressures on host countries, which tend to be low–income countries like Pakistan or Kenya. The UN has launching its biggest–ever aid appeal and estimates that half of Syria's population will need humanitarian aid by the end of 2013. Long–term, voluntary repatriation is the best solution, but is only possible when it safe for citizens to return. (*BBC News*, 16 July 2013)

In its annual State of the World Population for 2013, the UN urged governments to reduce teenage pregnancies by increasing girls' human capital, rather than measures to prevent pregnancy. It found that each year, nearly 20 000 girls below the age of 18 give birth, mostly in the developing world. Girls under the age of 15 account for more than 25% of this figure, equating to 2 million births each year. As the young population grows in developing countries, this figure could rise to 3 million by 2030, and underlying causes include poverty, gender inequality, sexual violence and child marriage. Impoverished, rural and under–educated girls are more likely to become pregnant compared with their wealthier, educated, urban counterparts. Girls are more likely to experience problems if they become pregnant too soon after puberty, and around 70 000 girls in developing countries die each year as a result. Tackling teenage pregnancy could also reduce these countries' overall high fertility rates. (*Financial Times*, 30 Oct 2013)

Economy

A report by the UN Environment Programme and the International Fund for Agricultural Development reveal that investing in agriculture could reduce poverty in over one billion people who rely on agriculture. It states that over 80% of the food consumed in the developing world is provided by 2.5 billion people who manage small–scale farms. According to a previous study, increasing farm yields by 10% reduced poverty in Africa by 7% and in Asia by 5%. When agricultural gross domestic product (GDP) is increased by 1%, the impact on poverty is five times as great as when the GDP of other sectors is increased by 1%. Therefore investing in and supporting smallholders by providing them with growth opportunities and incentivizing sustainable farming, will further the progress towards reaching the anti–poverty Millennium Development Goals. (*UN News Centre*, 4 Jun 2013)

Momentum is steadily building towards the creation of a new international bank by the BRICS countries. Its leaders reviewed progress at a special summit on the sidelines of the St Petersburg G20 Summit in early September, with an expected final plan at the 6th official BRICS Summit in early 2014. Initial capitalisation is expected to be US$ 50 billion with 20% in cash and 80% in guarantees. This suggests that the bank could rapidly become a major agent in development financing and reducing poverty, focusing on infrastructure and sustainable development. The drivers behind its creation are a combination of growing BRICS economic power and frustration with the slow pace of reform of World Bank and IMF, plus the lack of growth in their volume of lending. The new bank will be closely watched to ascertain its influence on changing the development financing landscape for inclusive growth. (*Oxfam.org.uk,* 7 Jun 2013)

Talks to further liberalise trade markets between the EU and USA opened in June 2013. Mr David Cameron, the British Prime Minister, expressed hopes that a successful deal would create two million jobs world–wide, boosting global employment. Trade in goods and services between the EU and USA is worth US$ 1 trillion each year, and is the world's largest trading relationship. It is hoped that a deal would add US$ 137 billion to the US–economy, and US$ 161 billion to the EU–economy, thus helping the EU to recover from recent economic crises. Much of current USA–EU trade is already tariff–free, but there is scope for liberalising some areas, such as financial services and airline restrictions. Talks were stalled during the US Government shutdown in October 2013, but they are scheduled to conclude at the end of 2014. Concerns have been raised that further trade liberalisation could undermine citizen and consumer safeguards on food safety, data privacy and the environment. (*Financial Times*, 8 Jul 2013)

The UK's overall unemployment rate has fallen throughout 2013. However, it remains stubbornly high amongst people aged 16–24, with more than one million people in this group not in employment, education or training. According to a WHO review, this is a "public health time bomb waiting to explode." Unemployment has immediate health consequences, including a higher risk of depression and suicide, with increased risks of diseases such as cancer, heart disease and stroke in the longer–term. Prof. Sir Michael Marmot, the review leader, called for the government to look at the impact of their policies on peoples' lives, and the impact on inequality. "Health inequality, arising from social and economic inequalities, is socially unjust, unnecessary and avoidable, and it offends against the human right to health," he says. (*BBC News*, 30 October 2013)

Economic growth in the Eurozone faltered in the third quarter of 2013, reducing the impact of earlier growth which saw the currency zone emerge from an 18–month recessions. It expanded by 0.1% in the third quarter, compared to 0.3% in the second quarter. German growth slipped back to 0.3%, and the French economy shrank by 0.1% after growing 0.5% during the previous quarter. Weaker exports were at the heart of these declines. The poor data from the Eurozone's two economic powerhouses will cause concern over the durability of a wider recovery throughout the region, although there are hopes that growth will rebound in the final quarter of 2013 and throughout 2014. (*Financial Times*, 4 Nov 2013)

Energy

Stock price of Tesla Motors, Inc, the pioneering electric car producers, has skyrocketed from US$ 35.36 at the beginning of the year to nearly US$ 200 towards the end of the year. The outstanding performance can be attributed to stable demand and strong safety ratings of Model S, along with sustained innovations by the company. Tesla recently announced its plans to develop an autopilot system, which will allow the car to cover 90% of the miles driven on its

own. Tesla is aiming to launch the car in 2016, although a completely self–driven car will take much longer to develop. Apart from this, Tesla is also aiming to make its car more affordable to boost sales. The company is reportedly developing a comparatively cheaper car to make electric cars accessible to the masses. (*Zacks*, 20 Sep 2013)

▸▸ The World Energy Outlook's annual report predicts that energy prices in the USA will remain low, giving it an advantage over competitors. Any actions to reduce the impact of high energy prices should not mean decreasing efforts to address climate change, according to the report. Energy–related CO_2 emissions are set to rise by 2035, which could lead to a long–term average temperature increase of 3.6°C, far above the 2.0°C target. As a result, the report calls for more support of renewable energy sources. (*World Energy Outlook*, 12 Oct 2013)

▸▸ In October 2013, the British government announced plans to build Britain's first nuclear reactor since 1995. At its 1997 peak, nuclear power provided 26% of Britain's electricity; now it is 19% and is set to fall further as older plants close. This is planned to be the first of a dozen plants built by 2030, making Britain the biggest market for new nuclear developments outside Asia. The raw materials for nuclear power are cheap, and plants produce constant, low–carbon energy – vital for meeting carbon reduction commitments. Construction costs, however, are high and require much state support. Longer–term, renewable energy is getting cheaper whereas nuclear energy is becoming more expensive due to higher safety standards. Other countries are turning away from nuclear energy, but decades of underinvestment in Britain's energy infrastructure leave few options for meeting future energy and environmental needs. (*The Economist*, 26 Oct 2013)

▸▸ Across the USA's Midwest, 2013 was a banner year for wind energy. In May this year Warren Buffett's MidAmerican Energy announced a US$ 1.9 billion investment in Iowa's wind industry, which will be the largest investment of any kind in state's history. Moreover, the company Facebook announced that it would be building a new multi–million dollar data center in Iowa. This online social network explained that their decision is mainly due to the amount of power that Iowa generates from clean sources compared with neighboring states, which amounts to more than 25 percent of its energy derived from wind. (*Earth Techling*, 9 Dec 2013)

▸ Environment

▸▸ In his latest book, *Global Crisis,* military historian Geoffrey Parker examines how the frosts and famines of the 17th century's 'little ice age' sparked a global wave of revolution, religiosity and disease. Without emphasising any particular country, Parker observes the patterns of widespread poverty and starvation, and how ensuing epidemics and unrest challenged the strength of the Italian states, the empire of Ming China and the unity of Great Britain, amongst others. As populations shifted, diseases such as bubonic plague and typhus crossed borders, and weakened political structures succumbed to revolutionaries and opportunists. In panic, people turned to religion with renewed passion. Mr Parker argues that the parallel crises of a diverse range of nations reflect the caustic power of climate change, as well as the human response of fundamentalism and insurgence. (*WSJ*, 31 May 2013)

▸▸A study by the University of Minnesota found that agricultural productivity must increase by at least 60%, to provide enough food for the world's population by 2050. Yields of key crops are only projected to grow by 38–67% by 2050, which is insufficient if actual population increases are mid– to high–range of estimate ranges. This does not take into account the possible effects of climate change on agricultural productivity. Climate and environmental degradation could be accelerated if pristine land is cleared for agriculture to compensate for the shortfall. It emphasised other ways of improving the world's supply, such as increasing efficiency and cutting food wastage. (*The Guardian*, 20 June 2013)

▸▸In June 2013, the world's three biggest polluters (China, the USA and Europe) announced new carbon–reduction measures. Both China and the USA's measures are more ambitious and far–reaching than previous policies, and the EU announced new reductions in car emissions. US and Chinese approaches are characterized by introducing some ceilings on emissions and regulations on polluting activities. Apart from China's tentative introduction of a carbon–trading scheme in the city of Shenzhen, neither polluter tried to emulate the EU in introducing market mechanisms to control carbon emissions. Experts fear that this means pollution efforts will be ineffectual, and will not keep global temperature increases below 2°C – the maximum that most climate scientists believe to be safe. There are increasing calls for the introduction of a carbon tax, which is simpler and less vulnerable to fluctuations in emissions than current "cap and control" schemes. (*The Economist*, 29 Jun 2013)

▸▸According to a World Bank report, environmental degradation costs India US$ 80 billion a year, or about 6% of its gross domestic product with the main culprits being air

pollution, poor water supply and sanitation, and land degradation. Other surveys show that India has the world's worst air pollution, and 23% of child deaths are attributed to environmental causes. The report showed that cutting air pollution would not interfere with India's economic growth. Reducing large–dust particles by 30% would reduce GDP growth by 0.04% per annum, but would save an estimated US$ 47–105 billion from reduced damage to human health, plus cut CO_2 emissions by 30–60%. (*Financial Times*, 17 Jul 2013)

▸▸ According to a survey by the European Environmental Agency, Bulgaria's air quality is the worst in Europe, followed by Poland. It has the highest concentration of particle matter from industry, car fumes or other sources. This can cause health problems from asthma to cancer, and Bulgaria has one of the highest death rates from air pollution. Poor air quality is partly due to Soviet–era industrialisation with little attention to environmental issues, and a lack of resources for cleaning up its air. Industrial and vehicle pollution has been exacerbated by people switching to wood–burning for domestic use, as they cannot afford high energy prices. This is against a background of generally–improving air quality across Europe. (*NYT*, 5 October 2013)

Food, Water and Sanitation

▸▸ The UN Secretary–General, Mr Ban Ki–moon warned that the world risks running out of fresh water unless global water security is improved. There are more pressures on water supplies due to increasing energy generation, whilst extreme weather events hamper natural water storage, and climate change disrupts rainfall patterns and soil moisture levels. "Under current trends, future demands for water will not be met," he said. To put this into context, the US Geological Survey reports that although 70% of the earth's surface is covered by water, freshwater comprises 2.5% of this total, and only 1.3% of all fresh–water is accessible as surface water. The latest UN World Water Development Report called for resources from the Green Climate Fund to be directed at the challenges faced by the water sector. (*The Guardian*, 22 May 2013)

▸▸ At the July meeting of the African Union, leaders pledged to re–prioritise agriculture in their national policies, and redouble efforts to end hunger by 2025. This is against the backdrop of strong economic growth across much of Africa failing to eradicate hunger. Across Africa, nearly 240 million people (a quarter of the population) are undernourished, and more than 40% are children under five years of age. Leaders promised to intensify efforts to increase agricultural investment and productivity to meet this goal. They recognised the importance of women in agriculture, who comprise 70% of the agricultural work–force, and their need for access to credit and land; plus the need to expand Africa's trade partners. The final declaration did not set out any targets or cash commitments. (*The Guardian*, 2 Jul 2013)

▸▸ The World Bank's July Food Price Watch showed that food prices reached a new high in August 2012, sparking concerns about food security and poverty. Although food prices have since slowly declined, the linkages between food, security, aid and development are still under scrutiny. To date, debate has focused on short–term food aid vs long–term capacity building and developing resilience. The development agency ACDI/VOCA says that food emergencies will always exist. Effective programmes must co–exist with longer–term development, support market conditions, and be based on local needs. Supporting local farmers and companies to adopt drought–resistant seeds, climate–smart farming techniques, and intelligent distribution systems can help build capacity and resilience. This enables local food supplies to move from areas of surplus to deficit in times of crisis. Developing agriculture in emerging economies can also provide industries in developed economies with a new market for their commodities. (*World Bank Food Price Watch*, 31 July 2013)

▸▸ Today, 2.5 billion people lack access to safe sanitation, causing serious health problems and death. Most of these deaths could be prevented by improved sanitation, along with safe drinking water and better hygiene. In 2011, the Bill and Melinda Gates Foundation launched the "*Re–invent the Toilet*" Challenge to design toilets that capture and process human waste without piped water, sewer or electrical connections, and transform waste into useful resources such as energy or fertiliser at an affordable price. So far, it has funded 16 research institutions world–wide as part of the challenge. (*The Bill and Melinda Gates Foundation*, 3 Oct 2013)

▸▸ Water is becoming the main environmental problem in China, ahead of smog, habitat destruction and food safety. Yearly, China uses 400 m^3 of water per person, 25% of the USA level. It has 20% of the world's population but only 7% of its freshwater supplies, complicated by having most water in the south, and half the population and most agricultural land in the north. China is rapidly using up supplies, and much water is unusable due to pollution.

The World Bank put the related cost to China as 2.3% of GDP, mostly due to health damage. The government is increasing supplies to deal with water shortages, eg, canals that divert water from one part of the country to another. These projects divert water from neighbouring countries and have huge environmental impacts. Instead, experts recommend improving China's water efficiency, recycling more water used by industry, and reducing agricultural wastage and public consumption. (*The Economist*, 12 Oct 2013)

Peace and Human Rights

The 2013 Global Peace Index (GPI) ranks 162 countries by their security in society, degree of militarisation and the extent of conflict. It shows that levels of peace have dropped by 5% since 2008. There has also been a shift in the nature of conflict: though a decrease in hostility between states has occurred, a disproportionate increase in internal conflicts has occurred. So what are the implications? A decrease in peace does not only affect those involved in the conflict. The global economy has suffered greatly: the GPI states that in 2012, violence cost US$ 9.46 trillion US dollars, 11% of gross world product. This is 75 times more expenditure than official assistance provided to countries in need in 2012. The findings signal a need for greater focus on peace as a prerequisite for growth and prosperity. (*The Guardian*, 11 June 2013)

According to a report from the UNESCO Institute of Statistics and Education for All, the world is not on track to meet the Millennium Development Goal (MDG) of Universal Primary Education. In 2011, 57 million primary age children did not attend school. Despite this, international aid for basic education fell for the first time since 2002, with a reduction from US$ 6.2 billion to US$ 5.8 billion between 2010 and 2011. In this period, six of the ten largest bilateral donors reduced their basic education aid. This mainly affected low–income countries, who only received 33% of the total aid for primary schools. With only a 2% reduction in the number of out–of–school children between 2005 and 2011, the world is unlikely to meet education MDG. It therefore calls for post–2015 goals to include specific donor aid targets to ensure financing for education. (*UNESCO*, 28 June 2013)

Recent research shows that more than one in ten men surveyed in six Asian countries (Bangladesh, Cambodia, China, Indonesia, Papua New Guinea and Sri Lanka) admitted to raping a woman who was not their partner. This rose to nearly one in four men when partners were included. Questions were worded to avoid the word "rape," but whether the man had "forced a woman…to have sex." Answers varied for non–partners, from 4% in Bangladesh to 41% in Papua New Guinea. Sexual entitlement was the main reason, suggesting that transforming women's status is essential to ending the violence. More than one in seven rapists committed their first rape when they were younger than 15, and more than 50% before the age of 20, so targeting young people is also crucial. Figures were much higher in areas of recent conflict, and childhood trauma and exposure to violence may be additional factors leading men to rape. (*The Economist*, 10 Sept 2013)

The UN Food and Agriculture Organisation's report *The State of Food Insecurity in the World 2013* assesses world–wide levels of undernourishment, under–nutrition and progress towards the Millennium Development Goal's and World Food Summit's targets. It shows that by 2013, 842 million people (one in eight people worldwide) suffer from chronic hunger. Unacceptable as this figure is, it is 17% reduction from 1990–1992. If progress continues to 2015, the MDG hunger target will be nearly met. Growth must be shared to reduce hunger, and that reductions in hunger are most notable in East and South East Asia and Latin America. It noted the importance of improving agricultural productivity and increasing food production in reducing hunger and spurring economic growth. It drew attention under–nutrition and the corresponding role of nutrition–enhancing interventions to improve health, and the necessity of long term commitment to mainstreaming food security and nutrition. (*UN FAO*, 1 Oct 2013)

The World Economic Forum's annual Global Gender Gap Index captures and tracks the scope of gender–based gaps against economic, political, education and health criteria benchmarks, aiming to reduce gender gaps. It provides rankings that allow comparisons across countries, regions and income groups. Ranking is based on access to resources and opportunities, not availability. The Middle East, North Africa and sub–Saharan Africa have the greatest gender inequalities. There is wide variation between countries, as the Gulf States have invested heavily in female education, whereas others like the Yemen have very low levels of female education. Some sub–Saharan African countries (eg, Chad and the Ivory Coast) are near the bottom, but others (eg, Mozambique and Lesotho) perform better due to higher female labour force and political par-

ticipation rates. Overall, Nordic countries have the narrowest gender gaps, and perform well compared to southern Europe. Burundi, Lesotho and South Africa all feature in the top 30 countries with the lowest gender gaps, ahead of some developed countries, eg, Japan and South Korea. (*World Economic Forum*, 30 Oct 2013)

Science and Technology

Microbial drug resistance is a growing global health threat, but antimicrobial drug development does not offer the financial returns needed to secure investment from major pharmaceutical companies. To address this, the US Health and Human Services Department announced the payment of up to US$ 200 million over five years to GlaxoSmithKline, to enable the development of new antimicrobials for use in cases of drug resistance and bioterrorism. The US Congress also approved giving companies an additional five years' exclusivity for successful drugs, and directed the US Food and Drug Administration (FDA) to speed up approval of new drugs. Earlier in 2013, a new European public–private partnership to develop new antimicrobials was announced. COMBACTE (Combating Bacterial Resistance in Europe) has funding of US$ 265 million. (*New York Times*, 2 June 2013)

Bill Gates is a leading investor and supporter of the Berlin–based research network ResearchGate, which supports global research scientist collaboration. Dubbed the social network for scientists, it allows ease in exchanging scientific and experimental information, regardless of geographical location. Scientists and researchers can exchange information online and even look for potential collaborators. By allowing widespread accessibility, it aims to accelerate improvements in scientific knowledge. ResearchGate's Chief Executive, Mr Ijad Madisch, launched the network in May 2008. Mr Gates intends the network to be a catalyst for research in his efforts to eliminate global diseases. (*Reuters,* 4 June 2013)

In June, the Supreme Court ruled that human genes cannot be patented. The case involved Myriad Genetics, who discovered the BRCA1 and BRCA2 genes linked to increased risks of breast and ovarian cancer, thus becoming the only company to produce tests. Justice Clarence Thomas said "Myriad did not create anything," as genes were not modified and a product of nature cannot be patented. It is hoped that this ruling will enable the test to become more widespread and affordable. It has already led to two universities and three companies offering the tests at lower prices. The Obama administration backed the ruling. (*New York Times*, 14 Jun 2013)

Adding silver to antibiotics makes them between 10 and 1000 times more effective at fighting infections, research suggests. It could counteract the rise of drug–resistant microbes, a development that is described as both alarming and irreversible. Silver acts against Gram–negative bacteria – one of the two main types of bacteria, which are particularly difficult pathogens to treat. The research was led by Dr Jose Ruben Morones–Ramirez of the Howard Hughes Medical Institute at Boston University, and further studies will focus on testing how silver can be added to antibiotic injections or tablets for use in patients. (*BBC News*, 20 Jun 2013)

The 2013 Nobel Prize in physiology or medicine was awarded to three researchers who explained the workings of a cellular nano–technological system. James Rothman, Randy Schekman and Thomas Südhof explained how cellular bodies called vesicles – little bubbles encased in fat – are used to carry hormones, enzymes and other items around a cell, and how they export them outside it. This transport system is vital for everything from cell division to the regulation of bodily systems through hormones. Diabetes, botulism and several neurological illnesses are partly caused by malfunctioning cellular processes, and better knowledge of how they work will lead to improved treatments. (*The Economist*, 7 Oct 2013)

Why do we need international standards on responsible research publication for authors and editors?

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Delivering the best possible healthcare requires a reliable evidence-base of research publications. Both authors and editors have responsibilities when publishing research yet it can be hard to find guidance on these. Most journal instructions concentrate on style and formatting but give little or no information about research and publication ethics.

Peer-reviewed publication is a vital step in the research process and permits research findings to be communicated effectively to readers. The peer review process is designed to select work of relevance to particular audiences, to improve the quality of reporting, and thus increase its transparency (eg, allowing methods to be replicated) [1]. Although it is by no means perfect, there is some evidence that peer review performs these functions, or at least that the quality of articles tends to improve from submission to publication [2,3]. However, peer review cannot, by itself, prevent fraud or misconduct, although in some cases it may help detect them. The publication process is therefore based on a degree of trust in the honesty and intentions of authors, reviewers, and editors.

However, responsible conduct in publishing research is not always fully understood, and while egregious behaviour (such as copying a published article into a new document and submitting it to another journal with new author names) is easily recognised as misconduct (in this case, plagiarism), other practices may be harder to classify. Without a good understanding of the ethics and conventions of publication, it is possible for authors and editors to unwittingly overstep the mark and do something that others find unacceptable [4]. It is therefore helpful for journals and institutions to provide clear guidance for authors and editors on what is expected of them.

Box 1 Summary – Responsible research publication: International standards for authors. A position statement developed at the 2nd World Conference on Research Integrity, Singapore, July 22–24, 2010

- The research being reported should have been conducted in an ethical and responsible manner and should comply with all relevant legislation.
- Researchers should present their results clearly, honestly, and without fabrication, falsification or inappropriate data manipulation.
- Researchers should strive to describe their methods clearly and unambiguously so that their findings can be confirmed by others.
- Researchers should adhere to publication requirements that submitted work is original, is not plagiarised, and has not been published elsewhere.
- Authors should take collective responsibility for submitted and published work.
- The authorship of research publications should accurately reflect individuals' contributions to the work and its reporting.
- Funding sources and relevant conflicts of interest should be disclosed.

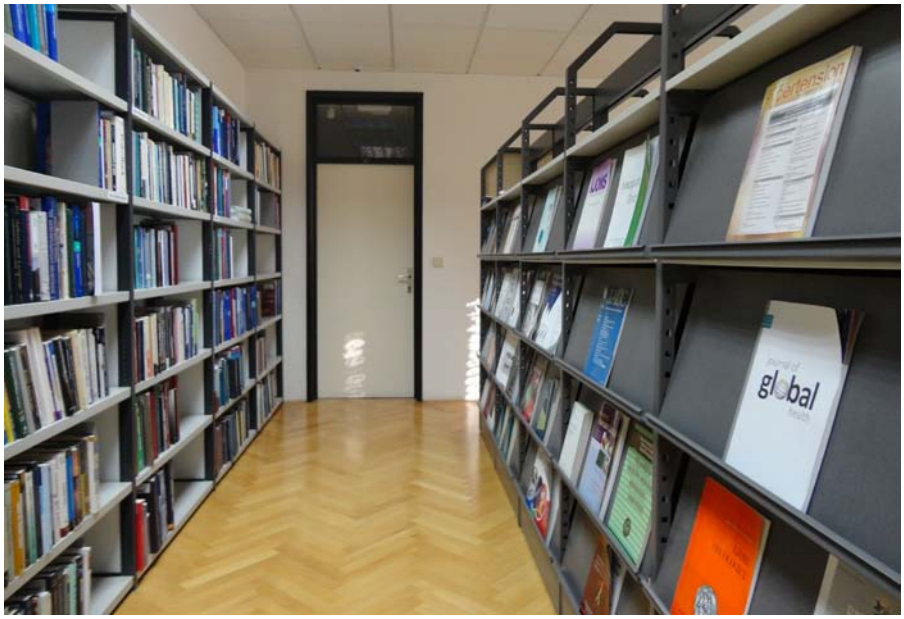

Photo: Courtesy of Leo Roglić

Establishing clear expectations is particularly important for projects involving global or inter-disciplinary collaboration since authors' experiences and publishing conventions may vary between countries, cultures, and disciplines [5]. For example, automatically adding the head of department's name to a publication may be viewed as an expected courtesy in some regions, but as an unacceptable form of guest authorship in others.

The position statements on Responsible Research Publication for authors and editors were developed with international input from researchers and editors and we hope they will be promoted, adopted, or adapted as required, by journals.

This pair of guidelines, one for authors (Box 1, Table 1), the other for editors (Box 2, Table 2), was designed to emphasize that all parties have responsibilities. Many journal guidelines focus on unacceptable behaviour by authors with little or no recognition that editors may abuse their powers and have important accountabilities. Once again, the peer review process depends on trust. Authors from small institutions or low-income countries may be concerned that editors or reviewers may be prejudiced against their work; therefore these guidelines are aimed to promote fairness in peer review. (Guidelines for peer reviewers have also been developed by the Committee on Publication Ethics and these are another useful resource [6]).

The guidelines on responsible research reporting were developed after wide international consultation with input from almost all parts of the world (Box 3). We are delighted that they are being promoted by the *Journal of Global Health* and hope they will be taken up by other journals. One practical reason for developing the guidelines was to spare journals and institutions the work involved in developing their own guidelines from scratch and we are happy for them to be referenced or adapted as required.

Developments in global health require the effective communication of research findings so they can contribute to a useful and reliable evidence-base that readers can trust. We hope that the statements are helpful for readers, authors, and editors.

Box 2 Summary – Responsible research publication: International standards for editors. A position statement developed at the 2nd World Conference on Research Integrity, Singapore, July 22–24, 2010

- Editors are accountable and should take responsibility for everything they publish.
- Editors should make fair and unbiased decisions independent from commercial consideration and ensure a fair and appropriate peer review process.
- Editors should adopt editorial policies that encourage maximum transparency and complete, honest reporting.
- Editors should guard the integrity of the published record by issuing corrections and retractions when needed and pursuing suspected or alleged research and publication misconduct.
- Editors should pursue reviewer and editorial misconduct.
- Editors should critically assess the ethical conduct of studies in humans and animals.
- Peer reviewers and authors should be told what is expected of them.
- Editors should have appropriate policies in place for handling editorial conflicts of interest.

Box 3 Responsible research publication position statements: Background information and acknowledgements

Note: This has been previously published in: Mayer T & Steneck N (eds) *Promoting Research Integrity in a Global Environment*. Imperial College Press / World Scientific Publishing, Singapore (Chapter 49, pp 305-7). ISBN 978-981-4340-97-7

The following position statements were developed at the 2nd World Conference on Research Integrity, held in Singapore in July 2010. They are designed to complement the Singapore Statement and to provide more detailed guidance on responsible research publication with particular emphasis on research integrity and publication ethics. The first statement is aimed at researchers in their role as authors of publications. The second statement is aimed at editors of scholarly journals that publish research.

The two statements were originally drafted by the named authors (Elizabeth Wager and Sabine Kleinert, the Chair and Vice-Chair of the Committee on Publication Ethics – COPE). These drafts were circulated before the meeting, discussed with the invited speakers, and revised to reflect these discussions. At the meeting in Singapore, the revised draft documents were presented and discussed in two sessions and further refined during a one-day, post-conference workshop. Both statements were then reworked to reflect the discussions in Singapore and circulated to those who had participated in the sessions and to members of the COPE Council and the International Council for Science (ICSU). However, while we hope such organizations may endorse the statements, they are primarily based on the views of participants at the Singapore meeting and therefore do not necessarily represent the official views of any of the participating organizations or the individuals' institutions.

While some differences in publishing conventions exist between fields, it was evident from the discussion that there is much common ground and also a desire to raise standards in the reporting of research. The two documents therefore aim to establish standards for authors and editors of scholarly research publications and to describe responsible research reporting and publishing practice. Given the special issues raised by research involving humans or animals, which may not apply to other types of research, both statements include a specific section on these. We hope the statements will be endorsed by research institutions, funders, professional societies, and publishers.

While it would be impossible to reflect the views of all researchers and editors, we were pleased to involve participants and reviewers from a wide range of academic fields including biology, forestry, earth sciences, the humanities, mathematics, medicine, philosophy, and political science. The Singapore meeting also brought together participants from Africa, Asia, Australasia, Europe, the Middle East, and North America. We hope the versions presented here reflect the lively debate that took place before, during and after the meeting. However, we also hope that participants and reviewers will appreciate that it was not possible to incorporate all the suggestions we received, because some were contradictory. We therefore offer these documents as the first step in a process aimed at improving the reporting and publication of research and hope the statements will be reviewed and revised, as necessary, at future meetings.

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Table 1 Responsible research publication: International standards for **authors**

Introduction

Publication is the final stage of research and therefore a responsibility for all researchers. Scholarly publications are expected to provide a detailed and permanent record of research. Because publications form the basis for both new research and the application of findings, they can affect not only the research community but also, indirectly, society at large. Researchers therefore have a responsibility to ensure that their publications are honest, clear, accurate, complete and balanced, and should avoid misleading, selective or ambiguous reporting. Journal editors also have responsibilities for ensuring the integrity of the research literature and these are set out in companion guidelines.

This document aims to establish international standards for authors of scholarly research publications and to describe responsible research reporting practice. We hope these standards will be endorsed by research institutions, funders, and professional societies; promoted by editors and publishers; and will aid in research integrity training.

1. Soundness and reliability	
1.1	The research being reported should have been conducted in an ethical and responsible manner and follow all relevant legislation. *[See also the Singapore Statement on Research Integrity, www.singaporestatement.org]*
1.2	The research being reported should be sound and carefully executed.
1.3	Researchers should use appropriate methods of data analysis and display (and, if needed, seek and follow specialist advice on this).
1.4	Authors should take collective responsibility for their work and for the content of their publications. Researchers should check their publications carefully at all stages to ensure methods and findings are reported accurately. Authors should carefully check calculations, data presentations, typescripts/submissions and proofs.
2. Honesty	
2.1	Researchers should present their results honestly and without fabrication, falsification or inappropriate data manipulation. Research images (eg, micrographs, x-rays, pictures of electrophoresis gels) should not be modified in a misleading way.
2.2	Researchers should strive to describe their methods and to present their findings clearly and unambiguously. Researchers should follow applicable reporting guidelines. Publications should provide sufficient detail to permit experiments to be repeated by other researchers.
2.3	Reports of research should be complete. They should not omit inconvenient, inconsistent or inexplicable findings or results that do not support the authors' or sponsors' hypothesis or interpretation.

2.4	Research funders and sponsors should not be able to veto publication of findings that do not favour their product or position. Researchers should not enter agreements that permit the research sponsor to veto or control the publication of the findings (unless there are exceptional circumstances, such as research classified by governments because of security implications).
2.5	Authors should alert the editor promptly if they discover an error in any submitted, accepted or published work. Authors should cooperate with editors in issuing corrections or retractions when required.
2.6	Authors should represent the work of others accurately in citations and quotations.
2.7	Authors should not copy references from other publications if they have not read the cited work.
3. Balance	
3.1	New findings should be presented in the context of previous research. The work of others should be fairly represented. Scholarly reviews and syntheses of existing research should be complete, balanced, and should include findings regardless of whether they support the hypothesis or interpretation being proposed. Editorials or opinion pieces presenting a single viewpoint or argument should be clearly distinguished from scholarly reviews.
3.2	Study limitations should be addressed in publications.
4. Originality	
4.1	Authors should adhere to publication requirements that submitted work is original and has not been published elsewhere in any language. Work should not be submitted concurrently to more than one publication unless the editors have agreed to co-publication. If articles are co-published this fact should be made clear to readers.
4.2	Applicable copyright laws and conventions should be followed. Copyright material (eg, tables, figures or extensive quotations) should be reproduced only with appropriate permission and acknowledgement.
4.3	Relevant previous work and publications, both by other researchers and the authors' own, should be properly acknowledged and referenced. The primary literature should be cited where possible.
4.4	Data, text, figures or ideas originated by other researchers should be properly acknowledged and should not be presented as if they were the authors' own. Original wording taken directly from publications by other researchers should appear in quotation marks with the appropriate citations.
4.5	Authors should inform editors if findings have been published previously or if multiple reports or multiple analyses of a single data set are under consideration for publication elsewhere. Authors should provide copies of related publications or work submitted to other journals.
4.6	Multiple publications arising from a single research project should be clearly identified as such and the primary publication should be referenced. Translations and adaptations for different audiences should be clearly identified as such, should acknowledge the original source, and should respect relevant copyright conventions and permission requirements. If in doubt, authors should seek permission from the original publisher before republishing any work.
5. Transparency	
5.1	All sources of research funding, including direct and indirect financial support, supply of equipment or materials, and other support (such as specialist statistical or writing assistance) should be disclosed.
5.2	Authors should disclose the role of the research funder(s) or sponsor (if any) in the research design, execution, analysis, interpretation and reporting.
5.3	Authors should disclose relevant financial and non-financial interests and relationships that might be considered likely to affect the interpretation of their findings or which editors, reviewers or readers might reasonably wish to know. This includes any relationship to the journal, for example if editors publish their own research in their own journal. In addition, authors should follow journal and institutional requirements for disclosing competing interests.
6. Appropriate authorship and acknowledgement	
6.1	The research literature serves as a record not only of what has been discovered but also of who made the discovery. The authorship of research publications should therefore accurately reflect individuals' contributions to the work and its reporting.
6.2	In cases where major contributors are listed as authors while those who made less substantial, or purely technical, contributions to the research or to the publication are listed in an acknowledgement section, the criteria for authorship and acknowledgement should be agreed at the start of the project. Ideally, authorship criteria within a particular field should be agreed, published and consistently applied by research institutions, professional and academic societies, and funders. While journal editors should publish and promote accepted authorship criteria appropriate to their field, they cannot be expected to adjudicate in authorship disputes. Responsibility for the correct attribution of authorship lies with authors themselves working under the guidance of their institution. Research institutions should promote and uphold fair and accepted standards of authorship and acknowledgement. When required, institutions should adjudicate in authorship disputes and should ensure that due process is followed.
6.3	Researchers should ensure that only those individuals who meet authorship criteria (ie, made a substantial contribution to the work) are rewarded with authorship and that deserving authors are not omitted. Institutions and journal editors should encourage practices that prevent guest, gift, and ghost authorship. Note: • guest authors are those who do not meet accepted authorship criteria but are listed because of their seniority, reputation or supposed influence • gift authors are those who do not meet accepted authorship criteria but are listed as a personal favour or in return for payment • ghost authors are those who meet authorship criteria but are not listed
6.4	All authors should agree to be listed and should approve the submitted and accepted versions of the publication. Any change to the author list should be approved by all authors including any who have been removed from the list. The corresponding author should act as a point of contact between the editor and the other authors and should keep co-authors informed and involve them in major decisions about the publication (eg, responding to reviewers' comments).
6.5	Authors should not use acknowledgements misleadingly to imply a contribution or endorsement by individuals who have not, in fact, been involved with the work or given an endorsement.
7. Accountability and responsibility	
7.1	All authors should have read and be familiar with the reported work and should ensure that publications follow the principles set out in these guidelines. In most cases, authors will be expected to take joint responsibility for the integrity of the research and its reporting. However, if authors take responsibility only for certain aspects of the research and its reporting, this should be specified in the publication.
7.2	Authors should work with the editor or publisher to correct their work promptly if errors or omissions are discovered after publication.
7.3	Authors should abide by relevant conventions, requirements, and regulations to make materials, reagents, software or data sets available to other researchers who request them. Researchers, institutions, and funders should have clear policies for handling such requests. Authors must also follow relevant journal standards. While proper acknowledgement is expected, researchers should not demand authorship as a condition for sharing materials.
7.4	Authors should respond appropriately to post-publication comments and published correspondence. They should attempt to answer correspondents' questions and supply clarification or additional details where needed.
8. Adherence to peer review and publication conventions	
8.1	Authors should follow publishers' requirements that work is not submitted to more than one publication for consideration at the same time.
8.2	Authors should inform the editor if they withdraw their work from review, or choose not to respond to reviewer comments after receiving a conditional acceptance.
8.3	Authors should respond to reviewers' comments in a professional and timely manner.
8.4	Authors should respect publishers' requests for press embargos and should not generally allow their findings to be reported in the press if they have been accepted for publication (but not yet published) in a scholarly publication. Authors and their institutions should liaise and cooperate with publishers to coordinate media activity (eg, press releases and press conferences) around publication. Press releases should accurately reflect the work and should not include statements that go further than the research findings.
9. Responsible reporting of research involving humans or animals	
9.1	Appropriate approval, licensing or registration should be obtained before the research begins and details should be provided in the report (eg, Institutional Review Board, Research Ethics Committee approval, national licensing authorities for the use of animals).
9.2	If requested by editors, authors should supply evidence that reported research received the appropriate approval and was carried out ethically (eg, copies of approvals, licences, participant consent forms).
9.3	Researchers should not generally publish or share identifiable individual data collected in the course of research without specific consent from the individual (or their representative). Researchers should remember that many scholarly journals are now freely available on the internet, and should therefore be mindful of the risk of causing danger or upset to unintended readers (eg, research participants or their families who recognise themselves from case studies, descriptions, images or pedigrees).

9.4	The appropriate statistical analyses should be determined at the start of the study and a data analysis plan for the prespecified outcomes should be prepared and followed. Secondary or *post hoc* analyses should be distinguished from primary analyses and those set out in the data analysis plan.
9.5	Researchers should publish all meaningful research results that might contribute to understanding. In particular, there is an ethical responsibility to publish the findings of all clinical trials. The publication of unsuccessful studies or experiments that reject a hypothesis may help prevent others from wasting time and resources on similar projects. If findings from small studies and those that fail to reach statistically significant results can be combined to produce more useful information (eg, by meta-analysis) then such findings should be published.
9.6	Authors should supply research protocols to journal editors if requested (eg, for clinical trials) so that reviewers and editors can compare the research report to the protocol to check that it was carried out as planned and that no relevant details have been omitted. Researchers should follow relevant requirements for clinical trial registration and should include the trial registration number in all publications arising from the trial.

Table 2 Responsible research publication: International standards for **editors**

Introduction

As guardians and stewards of the research record, editors should encourage authors to strive for, and adhere themselves to, the highest standards of publication ethics. Furthermore, editors are in a unique position to indirectly foster responsible conduct of research through their policies and processes. To achieve the maximum effect within the research community, ideally all editors should adhere to universal standards and good practices. While there are important differences between different fields and not all areas covered are relevant to each research community, there are important common editorial policies, processes, and principles that editors should follow to ensure the integrity of the research record.

These guidelines are a starting point and are aimed at journal editors in particular. While books and monographs are important and relevant research records in many fields, guidelines for book editors are beyond the scope of these recommendations. It is hoped that in due course such guidelines can be added to this document.

Editors should regard themselves as part of the wider professional editorial community, keep themselves abreast of relevant policies and developments, and ensure their editorial staff is trained and kept informed of relevant issues.

To be a good editor requires many more principles than are covered here. These suggested principles, policies, and processes are particularly aimed at fostering research and publication integrity.

Editorial Principles

1. Accountability and responsibility for journal content

Editors have to take responsibility for everything they publish and should have procedures and policies in place to ensure the quality of the material they publish and maintain the integrity of the published record (see paragraphs 4-8).

2. Editorial independence and integrity

An important part of the responsibility to make fair and unbiased decisions is the upholding of the principle of editorial independence and integrity.

2.1 Separating decision-making from commercial considerations

Editors should make decisions on academic merit alone and take full responsibility for their decisions. Processes must be in place to separate commercial activities within a journal from editorial processes and decisions. Editors should take an active interest in the publisher's pricing policies and strive for wide and affordable accessibility of the material they publish.

Sponsored supplements must undergo the same rigorous quality control and peer review as any other content for the journal. Decisions on such material must be made in the same way as any other journal content. The sponsorship and role of the sponsor must be clearly declared to readers.

Advertisements need to be checked so that they follow journal guidelines, should be clearly distinguishable from other content, and should not in any way be linked to scholarly content.

2.2 Editors' relationship to the journal publisher or owner

Editors should ideally have a written contract setting out the terms and conditions of their appointment with the journal publisher or owner. The principle of editorial independence should be clearly stated in this contract. Journal publishers and owners should not have any role in decisions on content for commercial or political reasons. Publishers should not dismiss an editor because of any journal content unless there was gross editorial misconduct or an independent investigation has concluded that the editor's decision to publish was against the journal's scholarly mission.

2.3 Journal metrics and decision-making

Editors should not attempt to inappropriately influence their journal's ranking by artificially increasing any journal metric. For example, it is inappropriate to demand that references to that journal's articles are included except for genuine scholarly reasons. In general, editors should ensure that papers are reviewed on purely scholarly grounds and that authors are not pressured to cite specific publications for non-scholarly reasons.

3. Editorial confidentiality

3.1 Authors' material

If a journal operates a system where peer reviewers are chosen by editors (rather than posting papers for all to comment as a pre-print version), editors must protect the confidentiality of authors' material and remind reviewers to do so as well. In general, editors should not share submitted papers with editors of other journals, unless with the authors' agreement or in cases of alleged misconduct (see below). Editors are generally under no obligation to provide material to lawyers for court cases. Editors should not give any indication of a paper's status with the journal to anyone other than the authors. Web-based submission systems must be run in a way that prevents unauthorised access.

In the case of a misconduct investigation, it may be necessary to disclose material to third parties (eg, an institutional investigation committee or other editors).

3.2 Reviewers

Editors should protect reviewers' identities unless operating an open peer review system. However, if reviewers wish to disclose their names, this should be permitted. If there is alleged or suspected reviewer misconduct it may be necessary to disclose a reviewer's name to a third party.

General Editorial Policies

4. Encourage maximum transparency and complete and honest reporting

To advance knowledge in scholarly fields, it is important to understand why particular work was done, how it was planned and conducted and by whom, and what it adds to current knowledge. To achieve this understanding, maximum transparency and complete and honest reporting are crucial.

4.1 Authorship and responsibility

Journals should have a clear policy on authorship that follows the standards within the relevant field. They should give guidance in their information for authors on what is expected of an author and, if there are different authorship conventions within a field, they should state which they adhere to.

For multidisciplinary and collaborative research, it should be apparent to readers who has done what and who takes responsibility for the conduct and validity of which aspect of the research. Each part of the work should have at least one author who takes responsibility for its validity. For example, individual contributions and responsibilities could be stated in a contributor section. All authors are expected to have contributed significantly to the paper and to be familiar with its entire content and ideally, this should be declared in an authorship statement submitted to the journal.

When there are undisputed changes in authorship for appropriate reasons, editors should require that all authors (including any whose names are being removed from an author list) agree these in writing. Authorship disputes (ie, disagreements on who should or should not be an author before or after publication) cannot be adjudicated by editors and should be resolved at institutional level or through other appropriate independent bodies for both published and unpublished papers. Editors should then act on the findings, for example by correcting authorship in published papers.

Journals should have a publicly declared policy on how papers submitted by editors or editorial board members are handled (see paragraph on editorial conflicts of interest: 8.2)

4.2 Conflicts of interest and role of the funding source

Editors should have policies that require all authors to declare any relevant financial and non-financial conflicts of interest and publish at least those that might influence a reader's perception of a paper, alongside the paper. The funding source of the research should be declared and published, and the role of the funding source in the conception, conduct, analysis, and reporting of the research should be stated and published.

Editors should make it clear in their information for authors if in certain sections of the journal (eg, commissioned commentaries or review articles) certain conflicts of interest preclude authorship.

4.3 Full and honest reporting and adherence to reporting guidelines

Among the most important responsibilities of editors is to maintain a high standard in the scholarly literature. Although standards differ among journals, editors should work to ensure that all published papers make a substantial new contribution to their field. Editors should discourage so-called 'salami publications' (ie, publication of the minimum publishable unit of research), avoid duplicate or redundant publication unless it is fully declared and acceptable to all (eg, publication in a different language with cross-referencing), and encourage authors to place their work in the context of previous work (ie, to state why this work was necessary/done, what this work adds or why a replication of previous work was required, and what readers should take away from it).

Journals should adopt policies that encourage full and honest reporting, for example, by requiring authors in fields where it is standard to submit protocols or study plans, and, where they exist, to provide evidence of adherence to relevant reporting guidelines. Although devised to improve reporting, adherence to reporting guidelines also makes it easier for editors, reviewers, and readers to judge the actual conduct of the research.

Digital image files, figures, and tables should adhere to the appropriate standards in the field. Images should not be inappropriately altered from the original or present findings in a misleading way.

Editors might also consider screening for plagiarism, duplicate or redundant publication by using anti-plagiarism software, or for image manipulation. If plagiarism or fraudulent image manipulation is detected, this should be pursued with the authors and relevant institutions (see paragraph on how to handle misconduct: 5.2

5. Responding to criticisms and concerns

Reaction and response to published research by other researchers is an important part of scholarly debate in most fields and should generally be encouraged. In some fields, journals can facilitate this debate by publishing readers' responses. Criticisms may be part of a general scholarly debate but can also highlight transgressions of research or publication integrity.

5.1 Ensuring integrity of the published record - corrections

When genuine errors in published work are pointed out by readers, authors, or editors, which do not render the work invalid, a correction (or erratum) should be published as soon as possible. The online version of the paper may be corrected with a date of correction and a link to the printed erratum. If the error renders the work or substantial parts of it invalid, the paper should be retracted with an explanation as to the reason for retraction (ie, honest error).

5.2 Ensuring the integrity of the published record – suspected research or publication misconduct

If serious concerns are raised by readers, reviewers, or others, about the conduct, validity, or reporting of academic work, editors should initially contact the authors (ideally all authors) and allow them to respond to the concerns. If that response is unsatisfactory, editors should take this to the institutional level (see below). In rare cases, mostly in the biomedical field, when concerns are very serious and the published work is likely to influence clinical practice or public health, editors should consider informing readers about these concerns, for example by issuing an 'expression of concern', while the investigation is ongoing. Once an investigation is concluded, the appropriate action needs to be taken by editors with an accompanying comment that explains the findings of the investigation. Editors should also respond to findings from national research integrity organisations that indicate misconduct relating to a paper published in their journal. Editors can themselves decide to retract a paper if they are convinced that serious misconduct has happened even if an investigation by an institution or national body does not recommend it.

Editors should respond to all allegations or suspicions of research or publication misconduct raised by readers, reviewers, or other editors. Editors are often the first recipients of information about such concerns and should act, even in the case of a paper that has not been accepted or has already been rejected. Beyond the specific responsibility for their journal's publications, editors have a collective responsibility for the research record and should act whenever they become aware of potential misconduct if at all possible. Cases of possible plagiarism or duplicate/redundant publication can be assessed by editors themselves. However, in most other cases, editors should request an investigation by the institution or other appropriate bodies (after seeking an explanation from the authors first and if that explanation is unsatisfactory).

Retracted papers should be retained online, and they should be prominently marked as a retraction in all online versions, including the PDF, for the benefit of future readers.

For further guidance on specific allegations and suggested actions, such as retractions, see the COPE flowcharts and retraction guidelines (http://publicationethics.org/flowcharts; http://publicationethics.org/files/u661/Retractions_COPE_gline_final_3_Sept_09__2_.pdf).

5.3 Encourage scholarly debate

All journals should consider the best mechanism by which readers can discuss papers, voice criticisms, and add to the debate (in many fields this is done via a print or online correspondence section). Authors may contribute to the debate by being allowed to respond to comments and criticisms where relevant. Such scholarly debate about published work should happen in a timely manner. Editors should clearly distinguish between criticisms of the limitations of a study and criticisms that raise the possibility of research misconduct. Any criticisms that raise the possibility of misconduct should not just be published but should be further investigated even if they are received a long time after publication.

Editorial Policies Relevant only to Journals that Publish Research in Humans or Animals

6. Critically assess and require a high standard of ethical conduct of research

Especially in biomedical research but also in social sciences and humanities, ethical conduct of research is paramount in the protection of humans and animals. Ethical oversight, appropriate consent procedures, and adherence to relevant laws are required from authors. Editors need to be vigilant to concerns in this area.

6.1 Ethics approval and ethical conduct

Editors should generally require approval of a study by an ethics committee (or institutional review board) and the assurance that it was conducted according to the Declaration of Helsinki for medical research in humans but, in addition, should be alert to areas of concern in the ethical conduct of research. This may mean that a paper is sent to peer reviewers with particular expertise in this area, to the journal's ethics committee if there is one, or that editors require further reassurances or evidence from authors or their institutions.

Papers may be rejected on ethical grounds even if the research had ethics committee approval.

6.2 Consent (to take part in research)

If research is done in humans, editors should ensure that a statement on the consent procedure is included in the paper. In most cases, written informed consent is the required norm. If there is any concern about the consent procedure, if the research is done in vulnerable groups, or if there are doubts about the ethical conduct, editors should ask to see the consent form and enquire further from authors, exactly how consent was obtained.

6.3 Consent (for publication)

For all case reports, small case series, and images of people, editors should require the authors to have obtained explicit consent for publication (which is different from consent to take part in research). This consent should inform participants which journal the work will be published in, make it clear that, although all efforts will be made to remove unnecessary identifiers, complete anonymity is not possible, and ideally state that the person described has seen and agreed with the submitted paper. The signed consent form should be kept with the patient file rather than sent to the journal (to maximise data protection and confidentiality, see paragraph 6.4). There may be exceptions where it is not possible to obtain consent, for example when the person has died. In such cases, a careful consideration about possible harm is needed and out of courtesy attempts should be made to obtain assent from relatives. In very rare cases, an important public health message may justify publication without consent if it is not possible despite all efforts to obtain consent and the benefit of publication outweighs the possible harm.

6.4 Data protection and confidentiality

Editors should critically assess any potential breaches of data protection and patient confidentiality. This includes requiring properly informed consent for the actual research presented, consent for publication where applicable (see paragraph 6.3), and having editorial policies that comply with guidelines on patient confidentiality.

6.5 Adherence to relevant laws and best practice guidelines for ethical conduct

Editors should require authors to adhere to relevant national and international laws and best practice guidelines where applicable, for example when undertaking animal research. Editors should encourage registration of clinical trials.

Editorial Processes

7. Ensuring a fair and appropriate peer review process

One of the most important responsibilities of editors is organising and using peer review fairly and wisely. Editors should explain their peer review processes in the information for authors and also indicate which parts of the journal are peer reviewed.

7.1 Decision whether to review

Editors may reject a paper without peer review when it is deemed unsuitable for the journal's readers or is of poor quality. This decision should be made in a fair and unbiased way. The criteria used to make this decision should be made explicit. The decision not to send a paper for peer review should only be based on the academic content of the paper, and should not be influenced by the nature of the authors or the host institution.

7.2 Interaction with peer reviewers

Editors should use appropriate peer reviewers for papers that are considered for publication by selecting people with sufficient expertise and avoiding those with conflicts of interest. Editors should ensure that reviews are received in a timely manner.

Peer reviewers should be told what is expected of them and should be informed about any changes in editorial policies. In particular, peer reviewers should be asked to assess research and publication ethics issues (ie, whether they think the research was done and reported ethically, or if they have any suspicions of plagiarism, fabrication, falsification, or redundant publication). Editors should have a policy to request a formal conflict of interest declaration from peer reviewers and should ask peer reviewers to inform them about any such conflict of interest at the earliest opportunity so that they can make a decision on whether an unbiased review is possible. Certain conflicts of interest may disqualify a peer reviewer. Editors should stress confidentiality of the material to peer reviewers and should require peer reviewers to inform them when they ask a colleague for help with a review or if they mentor a more junior colleague in conducting peer review. Editors should ideally have a mechanism to monitor the quality and timeliness of peer review and to provide feedback to reviewers.

7.3 Reviewer misconduct

Editors must take reviewer misconduct seriously and pursue any allegation of breach of confidentiality, non-declaration of conflicts of interest (financial or non-financial), inappropriate use of confidential material, or delay of peer review for competitive advantage. Allegations of serious reviewer misconduct, such as plagiarism, should be taken to the institutional level (for further guidance see: http://publicationethics.org/files/u2/07_Reviewer_misconduct.pdf).

7.4 Interaction with authors

Editors should make it clear to authors what the role of the peer reviewer is because this may vary from journal to journal. Some editors regard peer reviewers as advisors and may not necessarily follow (or even ask for) reviewers' recommendations on acceptance or rejection. Correspondence from editors is usually with the corresponding author, who should guarantee to involve co-authors at all stages. Communicating with all authors at first submission and at final acceptance stage can be helpful to ensure all authors are aware of the submission and have approved the publication. Normally, editors should pass on all peer reviewers' comments in their entirety. However, in exceptional cases, it may be necessary to exclude parts of a review, if it, for example, contains libellous or offensive remarks. It is important, however, that such editorial discretion is not inappropriately used to suppress inconvenient comments.

There should always be good reasons, which are clearly communicated to authors, if additional reviewers are sought at a late stage in the process.

The final editorial decision and reasons for this should be clearly communicated to authors and reviewers. If a paper is rejected, editors should ideally have an appeals process. Editors, however, are not obliged to overturn their decision.

8. Editorial decision-making

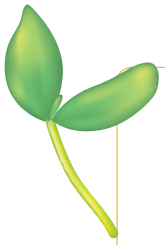
Editors are in a powerful position by making decisions on publications, which makes it very important that this process is as fair and unbiased as possible, and is in accordance with the academic vision of the particular journal.

8.1 Editorial and journal processes

All editorial processes should be made clear in the information for authors. In particular, it should be stated what is expected of authors, which types of papers are published, and how papers are handled by the journal. All editors should be fully familiar with the journal policies, vision, and scope. The final responsibility for all decisions rests with the editor-in-chief.

8.2 Editorial conflicts of interest

Editors should not be involved in decisions about papers in which they have a conflict of interest, for example if they work or have worked in the same institution and collaborated with the authors, if they own stock in a particular company, or if they have a personal relationship with the authors. Journals should have a defined process for handling such papers. Journals should also have a process in place to handle papers submitted by editors or editorial board members to ensure unbiased and independent handling of such papers. This process should be stated in the information for authors. Editorial conflicts of interests should be declared, ideally publicly.



Competing interests:

When this statement was developed, EW was Chair and SK was Vice-Chair of the Committee on Publication Ethics (COPE) (these were unpaid positions). COPE supported the 2nd World Conference on Research Integrity and provided funding for EW to attend the meeting in Singapore. No other funding was received for this project. EW is a self-employed consultant and provides publication training to researchers and acts as a consultant to pharmaceutical companies. SK is an employee of Elsevier.

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Strength in numbers?
Grouping, fund allocation and coordination amongst the neglected tropical diseases

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Neglected tropical diseases (NTDs) is a term used to describe a heterogeneous group united not by pathophysiology or geography, but by their perpetuating the poverty of "invisible people". Their burden is laid on one billion of the world's poorest, who are both at greater risk of contracting the diseases, and of being trapped in poverty by the ensuing effects on their health [1]. The diseases tend to co–exist and can be found in 149 of the 193 countries in the world, of which 100 countries are co–endemic for at least two of the NTDs and 30 countries are endemic for six or more [2].

As use of the term "NTD" has grown in recent years, its success in collecting together a group of diseases that are largely unheard of in high–income countries and using their combined burden to give the whole group added moral, political and economic weight, has been significant. Although precise estimates vary, grouped together the NTDs have a combined global disease burden comparable to that of diseases such as tuberculosis, malaria and human–immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) [3]. This combined power has brought these diseases from the halls of global health institutions to the attention of a wide range of stakeholders including the media, politicians, philanthropists and the general public. Both scientific interest in the diseases, as measured by research publications, and internet searches for constituent diseases through Google and Yahoo!, have increased over the last decade [4]. Similarly, from 2007 to 2011, the funding for NTDs increased by over 70% [5].

Photo: Graphic designed by Jennifer Matsumoto for UAEM (courtesy of the author)

However, the concept of NTDs is not being utilized to its full potential. Lobbying for funding, particularly regarding increasing access to currently available treatment, is still often done on an individual disease basis, and there is no discernible link between indicators such as research and development (R&D) funding and attributable disease burden in DALYs and deaths. Greater global coordination for the diseases, to a degree met by the London Declaration [6], may unravel with competing health issues coming to the fore and the partial completion of the main aims of the declaration. Over the past 18 months great progress has been made towards achieving the goals of the WHO roadmap to NTD control. Yet, as seen with previous control programmes, long–term international support and coordination is needed if gains are to be built upon rather than allowed to slide [7,8]. Although initiatives such as the London Declaration have improved collaboration in this field, they are limited in their scope to truly coordinate the fight against NTDs in the post–2020 era. An international coordinating committee should harness the combined power of these diseases to lobby on their behalf, collecting funds that will then be distributed on a more equitable and trans-

parent basis, whilst ensuring the long–term monitoring and viability of programmes put in place. We aim to expand on the need for an international coordinating committee and attempt to outline the roles of such a committee.

NTD BURDEN AND R&D FUNDING

There is no precise definition as to which diseases constitute NTDs: WHO officially lists 17 diseases [2], the Public Library of Sciences uses a wider list of 37 diseases [9], whilst most often the term refers to a 'core' of 13 diseases [1]. This is further complicated by the terms neglected tropical diseases and neglected diseases being used interchangeably in academic literature [10]. Different stakeholders using the same term at any given time to encompass different diseases makes it difficult to set specific targets for control or to lobby for funding for NTDs as a group. Consequently, attention and funding are more aligned with the success of advocacy groups for individual diseases, with heavy reliance on pharmaceutical company donations, than to any objective criteria such as disease burden, attributed deaths or the need for new drugs, diagnostics and vaccines (**Figure 1**). A similar discrepancy was described by Enserink in 2009 [11].

Of the 13 "core" NTDs shown in **Table 1**, 37.1% of 2007–2011 NTD R&D funding was directed towards the kinetoplastids (leishmaniasis, human African trypanosomiasis, and Chagas disease), which together represent 7.5% of the DALYs and 20% of deaths caused by NTDs. In contrast, over the same period, the helminthiases (lymphatic filariasis, schistosomiasis, hookworm infection, ascariasis, trichuriasis, and onchocerciasis) which make up 87% of NTD DALYs and 75% of deaths due to NTDs, received only 18.5% of the funds disbursed. Thus, although funding has increased to NTDs as a block since the grouping took root, overall funding has clearly not been shared equitably amongst the diseases, as illustrated in **Figure 1**. The funding discrepancies outlined can be explained in part by looking at the product development partnerships (PDPs) in place for different diseases and the high prevalence of certain diseases in middle–income countries; the former generally attract charitable funding and the latter affect countries that are increasingly more able to invest into R&D programmes [11,13]. The result has been an ad hoc approach to R&D into these diseases, rather than an approach aligned with need.

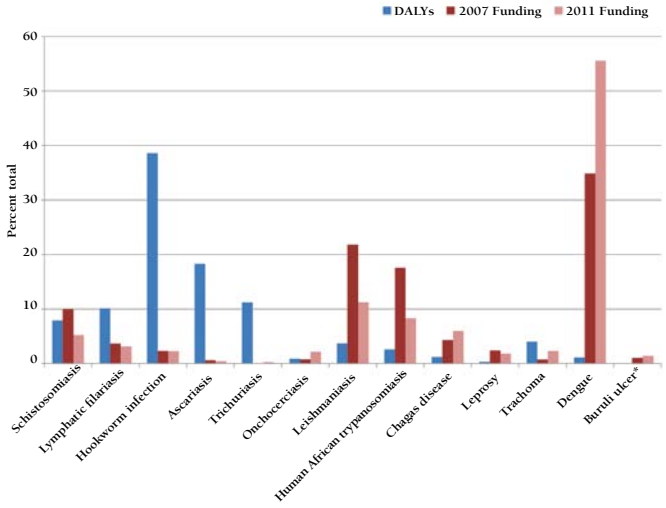


Figure 1. Misalignment of disease burden and funding. Discrepancies in disability adjusted life years (DALY) and funding allocation for various neglected tropical diseases. Estimated DALYs from Hotez et al. [3]; funding data from G–finder 2012 [5]. Asterisk – DALY burden unknown [3].

LONG TERM SUPPORT

The long–term commitments needed for the continued success of the 2020 Roadmap and London Declaration must not be underestimated. WHO's roadmap impresses the vital need to foster skills and systems in host nations independent of vertically integrated global programmes, so that long–term control of NTDs can be achieved [14]. Without health system capacity building in host nations, scaling down of global efforts and attention can be perilous. In the eight years leading up to 1964, the United Nations Children's Fund (UNICEF), in conjunction with WHO, undertook to control Yaws, a disease related to syphilis. Their efforts achieved a 95% reduction in cases, from 50 million to 2.5 million, at which point programmes were transferred to local primary health care, without simultaneous attempts to strengthen already overstretched systems [7]. Control of Yaws was lost, and 44 years later WHO had to launch a new elimination attempt [14]. Similarly, in the case of Leprosy, control through drug treatment alone is not enough; education and rehabilitation are also part of the treatment process and must continue even when drug treatment is no longer needed [15]. A 'post elimination strategy' is required for the long–term control of the disease as it will inevitably be difficult to generate financial and political support for implementation of appropriate surveillance systems and after care for patients, once the disease has been declared to have been eliminated [16]. The first WHO report on NTDs used the term 'elimination' somewhat loosely to refer to the removal of a disease as a public health problem [2]. The second WHO report resolved any ambiguity by defining "elimination" as it is conventionally used, "reduction to zero incidence … in a defined geographical area" [17]. This marks a significant difference in the end goal of the objectives set out in the WHO roadmap to tackle NTDs.

The rhetoric associated with the London Declaration hints at a world free from NTDs post–2020. This raises concerns

Table 1. Disability adjusted life years (DALY), deaths and proportional funding for neglected tropical diseases (NTD)

Disease	DALYs* millions	Deaths*	Proportion of NTD DALYs (%)	Proportion of NTD deaths (%)	% of total NTD funding, 2007–11	Change in funding, 2007–11 (%)¶
Schistosomiasis	4.5	280 000†	7.9	50.7	6	–8.6
Lymphatic filariasis	5.8	0	10.1	0	3	140
Hookworm infection	22.1	65 000	38.6	11.8	2.3	9.6
Ascariasis	10.5	60 000	18.3	10.9	0.5	24
Trichuriasis	6.4	10 000	11.2	1.8	0.2	630
Onchocerciasis	0.5	0	0.9	0	2	390
Helminthiases‡	49.8	415 000	87	75.2	18.5	57
Leishmaniasis	2.1	51 000	3.7	9.2	15.3	–9.7
Human African trypanosomiasis	1.5	48 000	2.6	8.7	10.2	–17
Chagas disease	0.7	14 000	1.2	2.5	4.6	140
Kinetoplastids‡	4.3	113 000	7.5	20.4	37.1	5.3
Leprosy	0.2	6000	0.3	1.1	2.2	32
Trachoma	2.3	0	4	0	1	470
Dengue§	0.7	19 000	1.1	3.4	41.1	180
Buruli ulcer	ND	ND	ND		0.9	140
Total	57.3	552 000				
HIV/AIDS	84.5	2 000 000				
Malaria	46.5	890 000				
Tuberculosis	34.7	1 400 000				

ND – Not determined.

*Figures quoted from Hotez et al., 2006 [3]. The data in the table are more widely used than other estimates as they take into some degree of long–term chronic disability and thus are believed to be more accurate [12].

†Death estimates for Africa only.

‡Figures include funding for multiple diseases as well as individual helminthiases and kinetoplastids funding.

§Estimates from G–FINDER report (2012) [5].

¶All funding figures calculated from information available in the G–FINDER report (2012) [5].

that NTDs will no longer considered to be sufficiently problematic to draw the support needed for long–term control. A 'quick fix' top–down approach is most susceptible to this; strengthening existing health care systems to enable them to deal with NTDs remains vital [8].

NEW COORDINATING COMMITTEE

We believe the World Health Organisation (WHO) has a central role in overseeing long term control of the NTDs. WHO has a mandate bestowed by member states, which allows the organisation to effectively and accountably coordinate disease control on an international level. The success of the NTD branding tool should perhaps be extended to include a number of other diseases: killers such as diarrhoeal illnesses and pneumonia, both of which have yet to find a branding frame that resonates with the international community, despite their dramatic DALY burden and attributed deaths [18]. Importantly, like other NTDs, these are diseases that perpetuate poverty and controlling them will result in additional downstream economic, humanitarian and developmental benefits [19]. A difficulty with such a WHO–led approach is the stretched finances of the organisation, in light of emerging global health threats, including the burden of non–communicable diseases, which demand ever greater resources.

The WHO Department of Control of Neglected Tropical Diseases has made great strides in NTD control since its establishment in 2005 [17]. In 2013, the first ever World Health Assembly resolution on all 17 NTDs was passed. To date, the department has mostly concerned itself with what were previously termed "tool–ready" diseases and laudably aims to maximise access to NTDs for which we currently have control measures. However, many of the NTDs, including Chagas disease, leishmaniasis and Human African trypanosomiasis, are still in need of innovative solutions [13].

We propose the establishment of a committee within the WHO Department of Control of Neglected Tropical Diseases which primarily concerns itself with two aims. First, the committee would capitalise on the dynamic nature of NTDs, regularly conducting reviews to reflect the current disease climate and to decide which new diseases should fall under the NTD umbrella. In this way, the successful branding technique of the NTDs can be magnified to deal with current and future neglected diseases, and help break the destructive cycle of poverty.

Second, by advocating on behalf of the diseases as a group, the committee could draw on the strengths of the NTD concept and aid the disbursement of resources on a more equitable basis. A remit to focus on long term control would allow the committee to supplement the great strides made under the London Declaration and widen the scope

of efforts to consider other NTDs not addressed under the WHO 2020 roadmap. Coordinated resource allocation can jointly tackle the multiple diseases endemic in an area. In addition a degree of "means testing" can be used in order to ensure R&D finances are directed towards the less well–funded NTDs and away from those which are already being successfully tackled. Member states at the sixty–sixth World Health Assembly this year endorsed the establishment of an observatory to monitor global health R&D investments, including investments into NTDs [20,21]. Using this in conjunction with data from recent efforts to measure the global burden of disease will aid stakeholders to achieve better alignment of resource allocation and health needs [22].

Ultimately, individual disease prevention programmes are inherently limited in their scope to tackle health issues as holistically as a multi–disease approach; the latter, by emphasising the multiple factors which cause afflictions, more effectively place people rather than diseases at the centre of efforts. Some NTDs are treated together with the same medicines; additional control of multiple diseases in co–endemic regions can be achieved more cost–effectively with an integrated treatment approach [1,23]. A committee focused on long term control would be well placed to assess the different needs of these populations and harmonise the efforts of the multiple stakeholders working to combat these diseases. The proposed committee would ensure the positive sentiments behind the London Declaration do not fail to achieve their potential due to lack of an obvious source of coordination and long term vision. This would help put in place sustainable programmes, ensuring disease control does not wane once the attention of policy makers and eyes of the world's media move on.

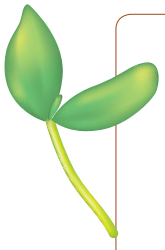
The WHO 2020 Roadmap, strengthened by the commitment of the signatories of the London Declaration of 2012, guarantees that the 13 "core" NTDs will receive attention for the rest of the decade. Even if the goals of the roadmap are achieved, by 2020 only one NTD will have been eradicated. Others will have the potential for resurgence as has happened in the wake of previous disease control and elimination programmes, and many of these diseases will still be in need of better drugs, vaccines and diagnostics.

In recent years, Neglected Tropical Diseases have received increasing attention from policymakers, funders and the global health community at large. There is a recognised need for collaboration in this field and new initiatives such as the London Declaration have been launched in an attempt to address this. However, while overall NTD funding has dramatically increased, the gains have not been shared equitably across individual diseases. Thus, there is a dramatic misalignment between funding for diseases and any discernible measure of disease burden. Sustainable strategies are required for long–term control of these diseases; lessons of past disease control attempts demonstrate a need for greater coordination than exist presently.

CONCLUSION

A coordinated approach is vital to improving the health of the world's poorest people. The NTDs represent only some of the health problems which afflict the "bottom billion" and compound poverty; addressing the wider determinants of health is an important part of NTD control whilst being fundamental to sustained improvements in global health [24].

In the long term, a WHO NTD department led committee serving an expanded group of neglected diseases of poverty, is required. The remit of a post–elimination strategy should not detract from current commitments to tackle NTDs; it is a method to build upon current gains in order to reduce the future disease burden and strain on health systems. Through better coordination of NTD R&D and control efforts, a truly sustainable mechanism can be created to systematically rid the world of these "ancient companions of poverty" [2].



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Beyond access to medicines: Eliciting high–income country support for a new global health research and development paradigm

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In recent decades, debates surrounding access to medicines have moved on to discussions on new ways of conducting research and development (R&D) to ensure equitable access from the outset. The market failure in the current R&D system and the need for new models has been apparent for decades [1,2]. A new framework for research and development to address health gaps primarily affecting low– and middle–income countries (LMICs) is currently one of the most contentious issues being debated at the World Health Organization (WHO). While WHO member states agree that urgent action is needed, deciding upon models, implementation mechanisms and funding commitments has proven difficult [3].

> There is a need to move from the notion of R&D being the responsibility of high–income countries to it being a shared responsibility: low– and middle–income countries need to rise to the challenge of creating a new, sustainable global R&D model for the future. Globalisation and changing disease patterns necessitate a joint, global effort to battle, inter alia, antimicrobial resistance.

The report of the Consultative Expert Working Group on Research and Development: Financing and Coordination (CEWG), published in 2012, marks the most recent milestone in the search of a new R&D paradigm (Box 1) [7]. The CEWG was set the task of finding a solution to lack of funding for diseases that are not catered for by today's market forces, and they did so laudably, analysing various proposals in great depth and impressively dealing with conflicts of interest. Requiring nations to make final commitments is inevitably a difficult ask in today's economic climate. Even so, framing the recommendations as purely a set of models and mechanisms to close the gaps in accessible health care technology for the poor and failing to highlight the benefits for high–income countries (HICs), may have undermined crucial support for a new R&D paradigm. We aim to point out the benefits HICs will accrue from adopting a new R&D framework. These benefits fall into three categories: increased investment by middle–income countries (MICs) into R&D so that HICs get increased returns on current investment; a more sustainable and efficient funding source for R&D; and direct benefits through the products of R&D into new antibiotics and vector borne diseases.

A new scheme for research and development (R&D) of medical technologies is needed. For decades the World Health Organization (WHO) has been the battlefield on which nations and non–state parties have attempted to improve access to essential medical technologies. In recent decades, debates surrounding access to medicines have moved on to discussions on new ways of conducting R&D to ensure equitable access from the outset. The report of the Consultative Expert Working Group on Research and Development: Financing and Coordination (CEWG) marks the most recent milestone in this endeavour. The CEWG proposed a global commitment to improve R&D funding and coordination for diseases primarily afflicting populations in low– and middle–income countries.

NO MORE FREE–RIDING – SHARED RESPONSIBILITY OF ALL NATIONS

One of the arguments for the globalisation of intellectual property (IP) rights through the World Trade Organization (WTO) agreement on Trade–Related Aspects of Intellectual Property Rights (TRIPS) in 1994 was that LMICs were able to "free–ride" on the research conducted in HICs [8]. The proponents of this argument held the view that LMICs, whilst benefiting from the products of the translation of research, failed to contribute to it. By setting global standards for IP protection, this "free–riding" has been addressed to a degree; LMICs (particularly MICs) now largely abide by global IP protection standards, many due to the threat of economic sanctions [1]. However, this has come at a cost: access to essential medicines for the world's poor has been jeopardised [2]. The impact of the globalisation of IP rights has been the subject of much debate. Many have questioned the wisdom of requiring countries that lack even basic health infrastructure to adhere to global standards in intellectual property [1,9]. Such debates have undoubtedly influenced the quest for new mechanisms to incentivise global health innovation [10].

Currently, the US is the world's largest contributor to R&D addressing diseases that primarily afflict the poor. It is the only nation that meets the 0.01% of GDP minimum expenditure advocated by the CEWG [11]. Most MICs, despite having made significant gains in GDP, have arguably not contributed their fair share to R&D into diseases that primarily afflict their populations [11]. A global commitment to increase public R&D funding would enable pooling of funds from all participating nations, thus addressing the so–called free–rider problem. Countries which already contribute vast amounts would see a greater return on investment. Moreover, an equitable and sustainable model would be created, replacing a framework based on charitable motives of HICs with one based on shared responsibility of all nations. It would also ensure that all contributing member states take ownership of investments and outcomes, a necessity for sustainability.

Knowledge created by research is a global public good. But for knowledge to be a true global public good, access has to be non–rivalrous and non–excludable: that is, without restrictions and freely available to all [12]. For this to happen, states have to take a greater part in upfront financing of research generated knowledge; legislative measures must be put in place to ensure that such knowledge is in fact accessible to all [13]. By making knowledge derived from research more widely available, the global community has the potential to minimise – and perhaps in time eliminate – duplicative research [14]. Duplicative research slows the knowledge generating process and increases expenses associated with research [15]. According to Subra Suresh, Director of the United States National Science Foundation, "More nations recognize that innovation, driven by science and engineering (S&E), is the fuel for economic growth, prosperity, and social well-being." [16]. As more actors from across the world increase contributions to the R&D landscape, minimising duplication of research will be ever more vital.

With the financial crisis sweeping the world, limited resources are available for R&D. These resources have to be coordinated effectively and prioritised to meet the greatest health challenges posed by the global burden of disease [17]. The CEWG suggested a convention under the auspices of WHO to ensure sustainable global governance for R&D, whereby member states, through a coordinating organ will be given the responsibility of prioritising and allocating funding.

HICs already have significant experience in advanced research, innovation, and technology transfer. They could benefit from a model with pooled funds, because the funds are likely to flow into existing research facilities, which could bring a boost for existing research projects and incentivise new ones.

MOVING TOWARDS SUSTAINABLE HEALTH RESEARCH FUNDING

Pharmaceuticals comprise a significant proportion of health expenditure; the pharmaceutical bill across the OECD

countries was estimated to have reached more than US$ 700 billion, accounting for around 19% of health spending. In an attempt to cut overall health costs, many European countries made efforts to control pharmaceutical expenditure before the economic recession through a mix of price and volume controls directed at physicians and pharmacies, as well as policies targeting specific products [18]. In this context, it is vital that the process of pharmaceutical R&D is made as efficient as possible.

The traditional models of incentivising innovation are not delivering, even for HICs [19]. The current IP system does not incentivise innovation on the basis of need, but possible profit. Lifestyle drugs and me–too drugs flourish whereas much–needed treatments receive little funding [20]. Many companies secretly pursue similar lines of research hoping to be the first to get a product patent. Pharmaceutical companies, which are primarily responsible to their shareholders, cannot solely be blamed. Structural mechanisms that do not reward needs–driven innovation must be rectified. Moving to a system that encourages openness by its very nature would reduce inefficiencies and cut costs [14,21,22]. The problem, then, would lie with incentivising translation of basic research to commercial products [10]. HICs, therefore, have an interest in ensuring that a significant proportion of the pooled funds end up as prize funds accessible to both private and public institutions. If such a model, based on openness, proves successful and minimises inefficiencies, there is potential for expanding the model.

IN THE SAME BOAT – HOW GLOBALISATION TRANSFORMS DISEASE PATTERNS

Globalisation plays an increasingly important role in human health and security [23]. With modern transportation technologies, migration and travelling have become vastly easier than a decade or two ago. People move easily between continents and, consequently, so do diseases. Indeed, many communicable diseases can now spread across countries and continents within their incubation periods, exemplified by the severe adult respiratory syndrome outbreak in 2002 and 2003, when only a concerted international effort prevented the spread from reaching pandemic proportions [24]. It is not just infectious diseases that easily traverse borders; it seems sedentary lifestyles and habits spread almost as easily. The rise of non–communicable diseases is a major global public health threat that must be

Photo: Courtesy of Sadie Regmi, personal collection

Box 1 The Consultative Expert Working Group on Research and Development: Financing and Coordination (CEWG)

WHAT

The CEWG was established by the 63rd World Health Assembly in 2010 and consisted of professionals with a wide variety of expertise. The final report was published in April 2012 and included a set of key recommendations to address the gaps in health R&D [4].

WHY

Securing access to affordable health technologies in low– and middle income countries continues to be among the greatest challenges in global health. Underpinning the challenge is a systematic market failure in health R&D which leads to an underproduction of public goods. Incentives such as intellectual property (IP) rights have traditionally been used to address this underproduction. However, the IP model, which incentivises private industry to invest in health R&D provided they get a monopoly on the end product, has failed to provide incentives for the development of health technologies addressing diseases that primarily affect the poor.

KEY RECOMMENDATIONS

Approaches to R&D:

- Open knowledge innovation, equitable licensing and patent pools should be embraced

Funding mechanisms:

- Countries should commit to spend 0.01% of GDP on government funded R&D to meet the health needs of the poor

Pooling resources:

- 20–50% of the funds raised should be channelled through a pooled mechanism

Coordination:

- A global health observatory under the auspices of WHO should be established [5,6]

Implementation:

- A binding global instrument for health R&D and innovation should be implemented
- Formal negotiations on an international convention should be initiated.

CHALLENGES

All member states agree that the market failure in health R&D is a pressing global health challenge. However, member states, in particular high–income countries, have been reluctant to support concrete, binding commitments. The most contentious issues have been the financing commitment of 0.01% of GDP and the suggested implementation through a binding convention.

addressed through shared global action, both when it comes to prevention and treatment [17].

Disease patterns in the world have changed significantly, not just because of the movement of people, lifestyles and norms, but also the movement of disease–carrying vectors due to a changing climate. For instance, West Nile Virus is spreading across the US at an increasing pace, having affected thousands of Americans in just a decade [25]. Similarly, the incidence rates of dengue fever in the US have increased greatly, and two types of mosquitoes capable of transmitting the dengue virus can now be found in 28 states. With further changes to the climate and the following rise in average temperature, this trend is expected to continue [26].

The spread of drug resistant microbes is another major global concern. There is a large discrepancy between the burden of infectious due to multidrug-resistant bacteria and investments into the development of new antibiotics. According to the Global Risks 2013 report issued by World Economic Forum the global risk of antimicrobial resistance is linked to the "failure of the international Intellectual Property (IP) regime" [27].

These public health concerns are not country-specific and dealing with them will require concerted global efforts. Indeed, with increased globalization, it is perhaps time we moved beyond the notion of viewing some diseases and challenges as being *tropical*. Recent history suggests that diseases which today primarily afflict populations in LMICs can evolve into true global public health threats imposing significant financial strain on health care systems in high–income countries as well.

CONCLUSIONS

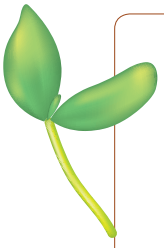
The world is in transition: countries which are powerful today will not necessarily remain as powerful tomorrow, diseases are moving beyond geopolitical borders, and the threat of common antimicrobials becoming ineffective is a pressing public health issue for all. Today's R&D system is clearly not optimal: drug pipelines are not aligned with global health needs, prices for end–products are becoming ever more unaffordable, and inefficiency and declining rates of true innovations are becoming hallmarks of the R&D process. These patterns have emerged over the last few decades and despite many perceptive analyses of the situation, action towards repairing the situation remains wanting.

The new R&D framework suggested by the CEWG addresses some of the crucial problems in health R&D as it encompasses a number of models that could improve the existing system. Unfortunately, most HICs have so far expressed little will to truly explore the possibility of a global shift in

norms. We believe one factor contributing towards such a response is the failure to highlight the potential benefits for these countries.

There are still several unanswered questions concerning how such a new R&D framework could work: how much would each country have to contribute to make the fund large enough, and how much would need to be pooled? How many countries would need to participate? How will the coordinating organ be organised and whom should it consist of?

Wider political interest in global health has meant that the health community currently has the opportunity to debate health R&D within a wider political arena; the CEWG's work is a solid platform on which to base these debates. WHO member states have started to identify promising demonstration projects that address the health R&D gaps through incorporation of open knowledge innovation mechanisms. This is a welcome start, but questions surrounding sustainable financing and ability or willingness to scale up such projects within a new normative framework still remain unanswered. A new R&D framework will not address every health challenge we face, but it could be a first step towards creating a sustainable system for pharmaceutical R&D where nation states bear shared responsibility for global public health.



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Foreign–trained medical professionals: Wanted or not? A case study of Canada

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In Canada, the shortage of health care professionals and the dependence on international medical graduates to fill gaps in the health care work force is expected to increase in the coming years. Over the last half century there has been a trend of the migration of medical graduates from low– and middle–income countries (LMICs) to the developed world. The recipient nation and the immigrating physicians benefit from this migration, however LMICs are losing critical health capabilities as a result of the loss of these medical graduates. There is growing global concern about the large variation among the world's nations in the availability of physicians and the negative impact of the scarcity of physicians on health equity, health disparities, communicable and non–communicable diseases. Canada, the focus of this paper, sources a significant percentage of its health care professionals from LMICs. The pathways for immigration, licensure and practice within each one of the recipient countries are complex and often not clearly laid out. As such, this paper seeks to describe a complex system – using Canada as a case study for a recipient country.

Definitions of the term "International Medical Graduate" vary but the Medical Council of Canada defines an IMG to be a graduate of a medical school outside of Canada or the United States, with the exception of US schools of osteopathic medicine.

In 2005 Mullan estimated that Canada had 23.1% International Medical Graduates (IMGs) in its workforce, 43.4% of whom were immigrants from LMICs. In comparison, the United Kingdom had the highest number of IMGs in its workforce (28.3%), 75.2% of them coming from LMICs; the corresponding figures were 25.0% (60.2% from LMICs) for the United States and 26.5% (40.0% from LMICs) for Australia [1]. There are no definitive guidelines for how international health professionals are incorporated into the Canadian health system, and therefore no simple way to assess efficiency of the process or to identify best practices.

IMGs, and often their health care manager sponsors, face a complex, multi–step process to gain a Canadian medical license. Definitions of the term "International Medical Graduate" vary but the Medical Council of Canada defines an IMG to be a graduate of a medical school outside of Canada or the United States, with the exception of US schools of osteopathic medicine [2]. IMGs may be Canadian citizens or foreign citizens (**Figure 1**). The location of post–graduate training is important, including for graduates of American residency programs. Graduates of American medical school still need to complete the Royal College of Physicians and Surgeons of Canada (RCPSC) or College of Family Physicians of Canada (CFPC) certification examinations prior to qualifying for independent practice in Canada.

Physicians – both specialist and family – are two of 29 careers on the Citizenship and Immigration Canada's (CIC)

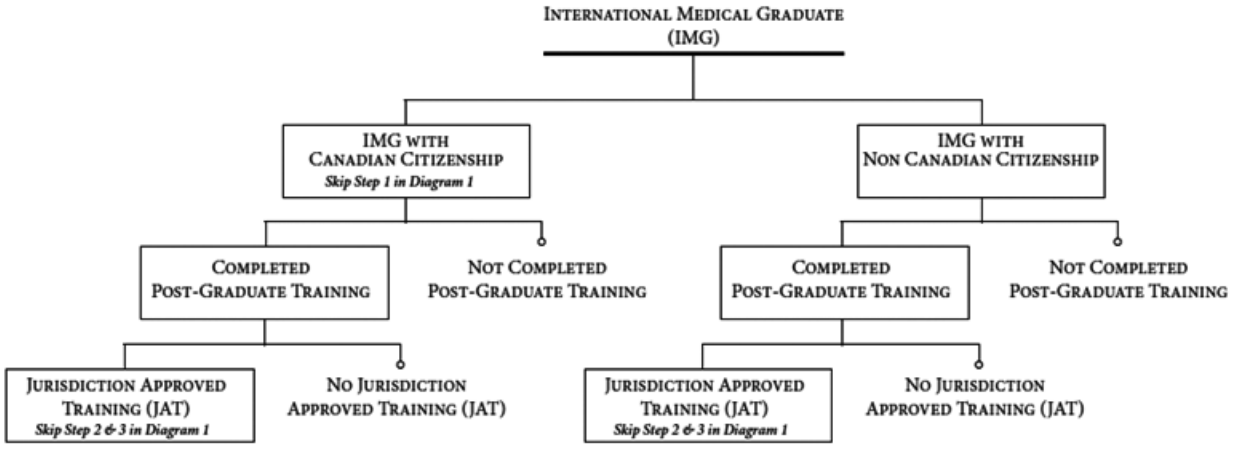

Figure 1. Understanding international medical graduates.

list of in–demand occupations for the Federal Skilled Worker Program [3,4]. The program is a gateway into Canada for individuals with language skills, education and work experience in select areas. IMGs come to Canada with various motivations, medical training regimens and areas of medical specialty. As a result, the roads for IMGs to attain a Canadian medical license are not of equal length, with each path dependent upon an individual's unique circumstances. Occasionally, qualification to practice medicine in Canada may require an IMG to largely recomplete various parts of their training, an obstacle that can be too lengthy or costly and so may prove to be insurmountable.

IMGs generally migrate from less wealthy countries, creating a significant imbalance in the global health workforce that has long been recognized as a problem by the World Health Organization, the World Health Assembly and others [5]. Some LMIC countries have made appeals to the World Health Assembly to take measures to decrease the flow of physicians to developed countries [5]. However, the establishment of policies to respond to these appeals is a complex proposition given an individual's right to migrate to the country of their choosing. These complexities are compounded by many developed countries' enticing recruitment strategies; images of beautiful mountain landscapes flash across the screen of *HealthMatch BC's* website, a health professional recruitment service funded by the Government of British Columbia, Canada. Part of the mandate of *Health Match BC* is to recruit internationally educated health professionals to British Columbia [6]. Canada claims to have a similar policy – not "actively" recruiting health professionals – although as far as the primary author is concerned, this claim is dubious given the presence of external, government funded bodies whose goal is to recruit health care professionals migrate to Canada. Perhaps it depends on how one defines "active recruitment". The primary author supposes that the Government of British Colombia as well as other provinces with these agencies do not view the use of sales techniques – beautiful landscapes and enticing descriptions of what your life will be like – as active recruitment. Which is convenient for Canada as there is increasing international concern about the large variation among the world's nations in the availability of health care professionals, resulting in negative impact on health disparities, health equity and communicable and non–communicable diseases [2]. Some countries, such as South Africa in 1995, have taken it upon themselves to ban the recruitment of doctors from other Organization of African Unity countries [5]. The primary author encourages Canadian province and territories to clearly define and explain what their stance is on the recruitment of IMGs, as well as defining terms such as "active" if they claim not to recruit IMGs from LMICs.

There is growing global concern about the large variation among the world's nations in the availability of physicians and the negative impact of the scarcity of physicians on health equity, health disparities, communicable and non-communicable diseases.

IMMIGRATION TO CANADA: THE FIRST STEP

IMGs who do not have Canadian citizenship must first attain an immigration status that permits them to legally remain in Canada (**Figure 2**). CIC has a number of immigration status classes. Among these, most IMGs are processed through the Economic Class (including the Federal Skilled Worker Program) and the Family Class [7]. Other routes through immigration include the Canadian Experience Class and Provincial Nominee Programs, though these are not available to all IMGs. IMGs staying with or reconnecting with family members who may be in, or moving to

Canada, are eligible for permanent residency through the CIC's Family Class, in which a relative who is a Canadian citizen or permanent resident must sponsor the applicant. Eligible relations include: common–law, same–sex and formally married spouses, dependent children, adopted children, parents and grandparents [7]. Successful applicants are given a permanent residence status. Applicants must include the results of an official language proficiency test in either French or English and have either a job offer or at least one year of continuous, paid, full–time work experience in one of the 29 in–demand occupations [7].

Instead of immediately immigrating, IMGs will often begin by obtaining a temporary work permit, which does not allow an IMG to live permanently in Canada. Still, because it can frequently be acquired more quickly than permanent residency, it is often used as a bridge towards permanent residency, allowing IMGs to begin their Canadian employment. Applications can be submitted from either outside Canada or, for those on a study visa, temporary residence or prior temporary work visa, from inside the country. In either situation applicants must have a job offer from a Canadian employer.

One route to permanent residency for individuals on a temporary work permit is the Canadian Experience Class. The Canadian Experience Class is often a gateway for temporary foreign workers or foreign students studying in Canada. It is available to skilled temporary foreign workers with at least two years of Canadian work experience in their field.

Temporary work permits are also a mechanism often used by IMGs going through a Provincial Nominee Program (PNP). Every province and territory except for Nunavut and Québec, which have different selection systems, has a PNP. The PNPs are not identical, as criteria vary between the provinces, though they do operate in a roughly similar manner. The programs are designed to help employers recruit foreign workers to occupy jobs they are having difficulty filling domestically. Finally, two other routes by which physicians could immigrate into Canada include the humanitarian class or as a refugee [8].

OBTAINING A MEDICAL LICENSE TO PRACTICE

The Medical Council of Canada (MCC), responsible for administering national examinations and providing the Licentiate qualification for entry into practice, provides a wide range of information about the licensure process on its website. There are many steps and variables to the licensure process – that are often completed prior to arrival in Canada (**Figure 2**). Most provinces and territories have now dedicated government–funded, third party recruitment agencies to help attract IMGs to their jurisdiction. These agencies provide support and counsel through the licensure process and often host, or link to, provincial medical job boards.

In Canada, there are two categories of medical license, full and provisional. The provincial colleges of physicians and surgeons are the medical regulatory bodies and medical licensing authorities in the jurisdictions responsible for verifying credentials and determining a physician's eligibility to practice in the provinces. An IMG must receive a license, either provisional or full, from the college before they are permitted to practice medicine. Licensure requirements are specific to each province. An IMG whose credentials meet the requirements to practice in one province, may not qualify in another [9].

A full medical license permits the physician to practice medicine with no terms, limitations or restrictions. The requirements for a full medical license are mainly uniform

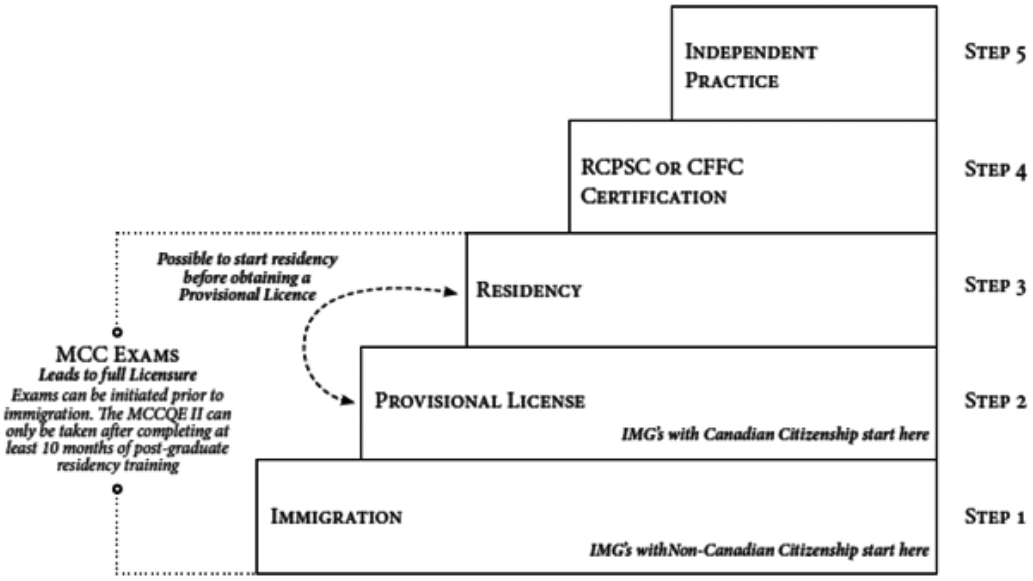

Figure 2. Five steps to independent practice.

across Canada, though some variations do exist [10]. The main qualifications a physician must possess in order to receive a full license include: a degree in medicine from an approved medical school, completion of two years of residency training, possession of the Licentiate of the Medical Council of Canada (LMCC), and certification by examination from either the College of Family Physicians of Canada (CFPC) or the RCPSC [11]. Many IMGs need time to achieve these standards and in some jurisdictions may begin practicing in Canada on a provisional license.

A provisional license can vary from province to province; thus there are over 100 different types of provisional licenses with variables including geographic, scope of practice and location of practice restrictions. A provisional license may also be referred to as a 'restricted', 'conditional', or 'temporary' license [10]. A provisional license allows a physician to practice medicine, but with restrictions, including the term of the permit and geographical or other restrictions [11]. Generally, among the main differences from full licensure requirements are that the physician does not need to have received the LMCC (though they generally do need to have passed the MCC evaluating exam), completed a full two years of residency, or be certified by either the CFPC or the RCPSC and they must have an employer–sponsor. Jurisdictions vary in approach, for example in British Columbia physicians can begin practicing on a provisional license without having completed the MCC evaluating exam, provided they pass the exam within the first year, while other provinces require IMGs to have passed the first part of the MCC qualifying exam prior to granting a provisional license [12].

National Medical Certification Exams are one final step required before an IMG may be approved for independent practice under full licensure by a provincial or territorial regulatory authority. This is a certification via examination by one of Canada's national certification bodies – RCPSC for specialists and CFPC for family physicians. IMGs may be permitted to practice in a province or territory without RCPSC or CFPC certification under the constraints of a provisional license [12]. IMGs interested to practice in Québec must make sure that various documentation including their medical degrees and certifications of relevant examinations has been verified by the PCRC [13].

Photo: Courtesy of Alasdair Campbell, personal collection

POST–GRADUATE RESIDENCY TRAINING

Many IMGs lack post–graduate residency training that is recognized as being up to Canadian standards and must therefore complete a period of remedial or post–graduate residency training before becoming certified to practice in Canada. The RCPSC has a jurisdiction approved training (JAT) assessment process wherein completion of post–graduate training/specialist certification in certain jurisdictions may allow an individual to bypass post–graduate training in Canada and be directly eligible for the RCPSC certification exam. These jurisdictions include: Australia, Hong Kong, Singapore, Ireland, Switzerland, the United Kingdom, New Zealand and South Africa [14]. IMGs from programs in these jurisdictions are still subject to an in–depth evaluation of their training by the RCPSC prior to having their residency training approved. On the other hand, post–graduate training in the United States is generally considered to be on par with Canadian training; therefore, IMGs from American programs may be exempt from this requirement. Regardless of citizenship, an IMG who has completed only their graduate medical training must complete post–graduate training in Canada in order to be eligible for RCPSC certification and independent licensure.

For family physicians, the CFPC offers a program similar to the JAT called International Accreditations. Physicians with training and certification in approved jurisdictions are able to apply for certification by the CFPC without the need to complete the CFPC exam. Canada also has regulations concerning how recently a physician has practiced. If a physician has been out of practice for more than three years out of the past five they are required to redo residency training regardless of their previous training and experience. Those IMGs who do need to complete residency training will have to compete for spots through the Canadian Resident Matching Service (CaRMS). Alberta is the one exception, matching IMGs to reserved spots through its own program. To be eligible to participate in the first iteration of the CaRMS match, IMGs must have graduated from a medical school that is either accredited by the LCME (Liaison Committee on Medical Education)/CACMS (Committee on Accreditation of Canadian Medical Schools), or listed on FAIMERs International Medical Education Directory, or the World Directory of Medical Schools, and have

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successfully completed the MCCEE or be scheduled to write the MCCEE within the upcoming year [15].

OBTAINING A RESIDENCY POSITION

Obtaining a residency position can be the most challenging step for many IMGs. The lack of residency positions for IMGs is consistently reported as being a major obstacle. Some provinces have a dedicated number of positions for IMGs and most provinces now allow IMGs to compete directly with Canadian medical graduates for additional placements through the CaRMS match. There may also be restrictions on residency positions based on discipline, with more spots available for family medicine than specialty disciplines. For instance, in 2010 there were 229 dedicated residency spots available for IMGs, with IMGs filling 380 total residency positions. Even so, there are vastly more IMG applicants for post–graduate medical training than there are positions. In the first iteration of the 2010 CaRMS match, 299 graduates from international medical schools, including the United States, received residency positions through CaRMS out of an applicant pool of 1532 individuals [15]. This means that for many IMGs the chances of securing a residency position without acquiring additional training or repeating medical school are slim.

SHIFTING APPROACHES TO IMGS

In the early 1990s, a number of barriers to IMG entrance were introduced as part of a national effort to reduce the number of physicians practicing in Canada. These remained in place until the end of that decade when both the Federal government and individual jurisdictions reversed their approach to physician supply, including IMGs, and developed a broad range of measures to increase access for IMGs to the education system and the provincial/territorial licensing process [16].

Now, hundreds of internationally educated physicians go through the process of becoming certified and/or licensed to practice medicine in a Canadian province every year. From 2000–2009 Canada added 7181 IMGs to its workforce, a significant increase from the 80s and 90s when Canada gained 5216 and 4755 IMGs respectively [17]. In total, nearly one quarter of the Canadian physician workforce areIMGs [18].

Some provinces and territories use Provisionally Licensed International Medical Graduates (PLIMGs) to help meet their physician health human resource needs. Provisional medical licenses permit physicians, who may not have completed all of the certification and regulatory requirements for full, independent licensure, to practice medicine with certain restrictions.

In their article on the use of PLIMGs in Canada, Audas et al. stated in 2005: "Typically, provisionally licensed IMGs are hired to meet an immediate short fall of physicians; they obtain a provisional license to gain entry to practice and tend to fill positions that Canadian medical graduates will not take" [10,12].

More specifically, a Memorial University study, by the same researchers, showed that, "PLIMGs make up a greater proportion of the physician workforce in N.L. [Newfoundland & Labrador], compared with any other Canadian province," [10,12] with many remaining in Newfoundland only long enough to complete their full licensing exams and then departing for more lucrative practice in other provinces as fully licensed physicians. This creates a feeder system of IMGs from some provinces to others.

A 2009 Canadian Institute for Health Information (CIHI) study on physician supply, distribution and migration corroborates this. It found that the jurisdictions with the highest percentage usage of IMGs among new physicians (Newfoundland and Labrador, Saskatchewan, Manitoba and Nova Scotia) also had the lowest ten–year retention rate of IMGs. For example, between 1995 and 1999, 60.6% of new physicians in Newfoundland and Labrador were IMGs, second to Saskatchewan with 62.2%, but ten years later the province had only retained 7 per cent of those IMGs. The study also tracked where IMGs went after leaving their first jurisdiction of registration. The results showed that, "a large proportion of new IMGs in Newfoundland and Labrador (63.3%), Nova Scotia (77.5%), Manitoba (80.4%) and Saskatchewan (92.1%) moved to Ontario, Alberta or British Columbia" [17]. Anecdotal information out of Newfoundland suggests that recently this trend is starting to change and the province is beginning to retain more of its IMGs [19].

In 2009 the Prime Minister and provincial and territorial leaders signed an update to the 1994 *Agreement on Internal Trade* (AIT) to facilitate the movement of people, investment, goods and services across Canada. The new update on labour mobility was the 9th Protocol of Amendment to the AIT and mandates that all regulated professions are entitled to full mobility rights across the country without having to undergo materially additional training, experience, examinations or assessments (barring an officially registered exception) [20]. For example, the official requirements for registration by the College of Physicians and Surgeons of

Ontario (CPSO) clearly state that licensed physicians from out–of–province may apply for Ontario licensing under the provisions of the AIT. The CPSO states that, "... AIT–related provisions enable application on the basis of holding a current Canadian out–of–province license, rather than on holding the specific postgraduate Canadian qualifications that would otherwise be required" [21].

The new AIT holds the potential to greatly ease the movement of IMGs within Canada. The agreement has compelled the provinces to develop national requirements promising full mobility for health care providers, meaning that PLIMGs would have the freedom to practice medicine in the jurisdiction of their choosing. All physicians, including IMGs, would still need to complete the credentialing process and pay the required fees [21]. Provinces with greater physician needs will no longer be able to use variances in the levels of provisional licensing to attract IMGs, potentially leading to health human resource shortages in those jurisdictions. Indeed, there have been some concerns raised that a national standard for medical registration, promising unlimited mobility across Canada, could lead to an exodus of IMGs from some provinces [22].

PROGRESS ON NATIONAL STANDARDS FOR MEDICAL REGISTRATION AND FUTURE DIRECTIONS

The mobility rights required by the AIT have prompted discussion and partnership by medical regulatory colleges across Canada, led by the Federation of Medical Regulatory Associations of Canada (FMRAC), and including the Medical Council of Canada (MCC) and Canada's schools of medicine to create national standards for medical registration [22]. Negotiations to reach a common system have been under way for some time and progress has been made, including the development of a new, standardized application process for medical licensure now expected by early 2014 [23].

There are significant questions that have yet to be answered, including who will pay for these national standards and what will the impact be? The IT systems needed for the application process are being funded by Human Resources and Skills Development Canada, the regulatory authorities and the MCC, but no money has yet been provided to cover the anticipated costs of implementing a new nation–wide system of testing and certification [23]. What level of funding will be required and where it should come from must still be determined. Without an answer to this funding question, the date of adoption of new standards, once a common set of standards has been agreed to, is still uncertain [22].

The AIT provides a mandate for common regulation to ensure physician mobility. Agreement on a national standard for full licensure is much more easily reached than one for provisional licensure. This is partly due to the different levels of dependence on IMGs that various provinces have, to help meet their health human resource needs. As noted earlier, some provinces may receive a significant, negative impact from the granting of nation–wide mobility to provisionally licensed physicians [22].

CONCLUSIONS

Based on all the information reviewed in this paper, it appears that Canada is continuously seeking foreign–trained medical professionals, particularly since the end of the 1990s. With an aging population leading to growing health needs this trend is set to continue. Citizenship and immigration are federally regulated so the immigration procedures described in this paper are applicable across all of Canada. By contrast, licensure varies province by province as discussed above. Information clarifying and describing the licensure process and multiple immigration entry points for IMGs will be of value for those who are in the system, for those who work with the system and for those involved in evaluating, commenting and revising the process. It must be noted that the licensure process is in flux. Furthermore, the development of a national standard for medical registration promises to greatly simplify the licensure process and level the currently uneven provincial requirements for licensure in Canada. But even once new national standards are in place, the path through immigration, residency training, licensure and employment promises to remain a difficult road to navigate.

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Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organization for the submitted work; no financial relationships with other organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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mHealth Series: mHealth project in Zhao County, rural China – Description of objectives, field site and methods

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Background We set up a collaboration between researchers in China and the UK that aimed to explore the use of mHealth in China. This is the first paper in a series of papers on a large mHealth project part of this collaboration. This paper included the aims and objectives of the mHealth project, our field site, and the detailed methods of two studies.

Field site The field site for this mHealth project was Zhao County, which lies 280 km south of Beijing in Hebei Province, China.

Methods We described the methodology of two studies: (i) a mixed methods study exploring factors influencing sample size calculations for mHealth–based health surveys and (ii) a cross–over study determining validity of an mHealth text messaging data collection tool. The first study used mixed methods, both quantitative and qualitative, including: (i) two surveys with caregivers of young children, (ii) interviews with caregivers, village doctors and participants of the cross–over study, and (iii) researchers' views. We combined data from caregivers, village doctors and researchers to provide an in–depth understanding of factors influencing sample size calculations for mHealth–based health surveys. The second study, a cross–over study, used a randomised cross–over study design to compare the traditional face–to–face survey method to the new text messaging survey method. We assessed data equivalence (intrarater agreement), the amount of information in responses, reasons for giving different responses, the response rate, characteristics of non–responders, and the error rate.

Conclusions This paper described the objectives, field site and methods of a large mHealth project part of a collaboration between researchers in China and the UK. The mixed methods study evaluating factors that influence sample size calculations could help future studies with estimating reliable sample sizes. The cross–over study comparing face–to–face and text message survey data collection could help future studies with developing their mHealth tools.

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The use of mobile devices in health care, also known as mHealth or mobile health [1], has increasingly gained attention over the past years worldwide [2-8] and in China [9,10]. The different functions of mobile phones, such as calling, messaging, camera and apps, can be used for various health care–related purposes. A promising use of mHealth is data collection, both in high–income countries [11-19], and in low– and middle–income countries [20-30].

There are now almost as many mobile phones subscriptions (6.8 billion) as people in the world [31]. Mobile phones are a particularly interesting example of information and communication technology as they became the first to have more users in low– and middle–income countries than in high–income countries [32]. The growth in mobile phone subscriptions is led by China and India, which have over 30% of the world's subscribers [33]. mHealth can be used in low– and middle–income countries to improve health systems and to reach the Millennium Development Goals [34-37].

However, though mHealth has the potential to improve health care, the current use of mHealth interventions in health care remains relatively low. Frequently mentioned barriers are methodological challenges and in result a lack of strong evidence for the use of mHealth [38-49].

In China, there were around 1.2 billion mobile phone subscriptions in 2013 [33]. Mobile phones are widely used both in urban and rural areas. While a relatively low proportion of households in rural areas have internet access or have a functioning landline telephone, nearly all households use at least one mobile phone [50].

We set up a collaboration between researchers in China and the UK, thereby combining our expertise in child health in China (Capital Institute of Pediatrics in Beijing), international child health and global burden of disease measurement (University of Edinburgh) and global mHealth (Imperial College London). The aim of this collaboration was to explore the use of mHealth in China. The Chinese researchers in this collaboration have a strong connection with the local health workers in Zhao County, Hebei Province in China, in which they have completed several child health studies during recent years [50-52]. Therefore, we selected Zhao County as a field site to conduct our mHealth research on child health data collection.

This is the first paper in a series of papers on a large mHealth project in Zhao County in rural China that is part of our collaboration. This paper included the aims and objectives of the mHealth data collection project, our field site, and the detailed methods of two studies that we conducted in Zhao County.

AIMS AND OBJECTIVES

The aims and objectives of our mHealth project in Zhao County in China were the following.

Aim 1: to advance mHealth data collection methodology

The first aim was to advance the mHealth methodology. We did this by two studies: (i) a mixed methods study exploring factors that influence the sample size of mHealth–based health surveys and (ii) a cross–over study determining the validity of an mHealth text messaging survey data collection tool. The methodology of these two studies was explained in detail in the methods section of this paper.

Objective 1: explore factors influencing the sample size of mHealth–based health surveys. Realistic sample size calculations are essential to conduct mHealth–based health surveys. There are several steps in the recruitment and follow–up of participants in mHealth studies where participants may be lost, from collecting mobile phone numbers to completing data collection. In text messaging data collection studies, an important issue affecting sample size calculation is the response rate of participants. Previous studies have reported variable response rates [11-13,15-17,19,23,27], but no studies have evaluated this issue and other problems in depth. The first study, a mixed methods study, explored factors influencing the sample size of mHealth–based health surveys. This will help future mHealth studies with estimating their sample sizes.

Objective 2: determine validity of an mHealth text message data collection tool. The validity of an mHealth data collection tool needs to be determined, because the mode of data collection can have great effects on data quality, especially when there are different modes of administration (interviewer–administered vs self–administered) [53]. While there are several studies that have compared mHealth text messaging data collection with other methods of data collection [11,14-16,19,23], most of these studies have only made within–group comparisons, used small samples, or only assessed properties of the used scale. The second study, a cross–over study, compared text messaging vs face–to–face interviews to determine validity of an mHealth text messaging survey data collection tool. This will help future mHealth studies with developing their mHealth tools.

Aim 2: explore promising areas for mHealth data collection implementation

The second aim was to show how the advancements in mHealth methodology from the first aim could be used for three mHealth implementation areas: (i) to replace cross–sectional health surveys, (ii) to monitor program implementation, and (iii) to measure burden of disease in a community. The first and third promising areas of mHealth implementation were shown in this mHealth series [54] and the second implementation area will be presented elsewhere (unpublished).

Objective 1: Explore the use of mHealth to replace cross–sectional health surveys. In the first paper, we explain how mHealth text messaging surveys could replace cross–sectional surveys [54]. Large cross–sectional health surveys are required to provide valid estimates of health [55-58] and to measure coverage of health interventions [59]. However, conducting large scale interviewer–administered surveys are

costly, time–consuming and can be difficult to perform. Pen–and–paper data collection are often the standard method in low– and middle income countries [60]. Using text messaging could be a more effective way for large–scale surveys, because it may decrease the number of field visits, include hard–to–reach populations, increase the survey sample size, eliminate interviewer bias and reduce recall bias.

Objective 2: explore the use of mHealth to monitor program implementation. In the second paper, we will show how mHealth could be used to monitor program implementation (unpublished). Planning and management are essential for health programs to achieve high coverage of key interventions and monitoring is crucial for process evaluation of intervention programs. However, often program monitoring data collection is difficult to perform, expensive and provides out–of–date and inaccurate results. mHealth data collection could facilitate monitoring, reduce costs and provide real–time data that could inform program management and planning [61].

Objective 3: explore the use of mHealth to measure burden of disease in a community. In the third paper, we explore how mHealth could be used to measure the burden of disease in a community (our unpublished results). There are very limited data available on the burden of childhood diseases and care–seeking for those diseases in developing countries [62-66]. Data are needed as appropriate health care strategies require a clear understanding of the burden of diseases [67]. mHealth could be a promising tool to measure the burden of disease, because the ubiquity of mobile phones allows mHealth tools to be easily scaled–up and used in different settings.

GENERAL INFORMATION ABOUT ZHAO COUNTY

Our field site was Zhao County in Hebei Province, China (**Figure 1**). This county has served as a field site for researchers from the Capital Institute of Pediatrics in Beijing

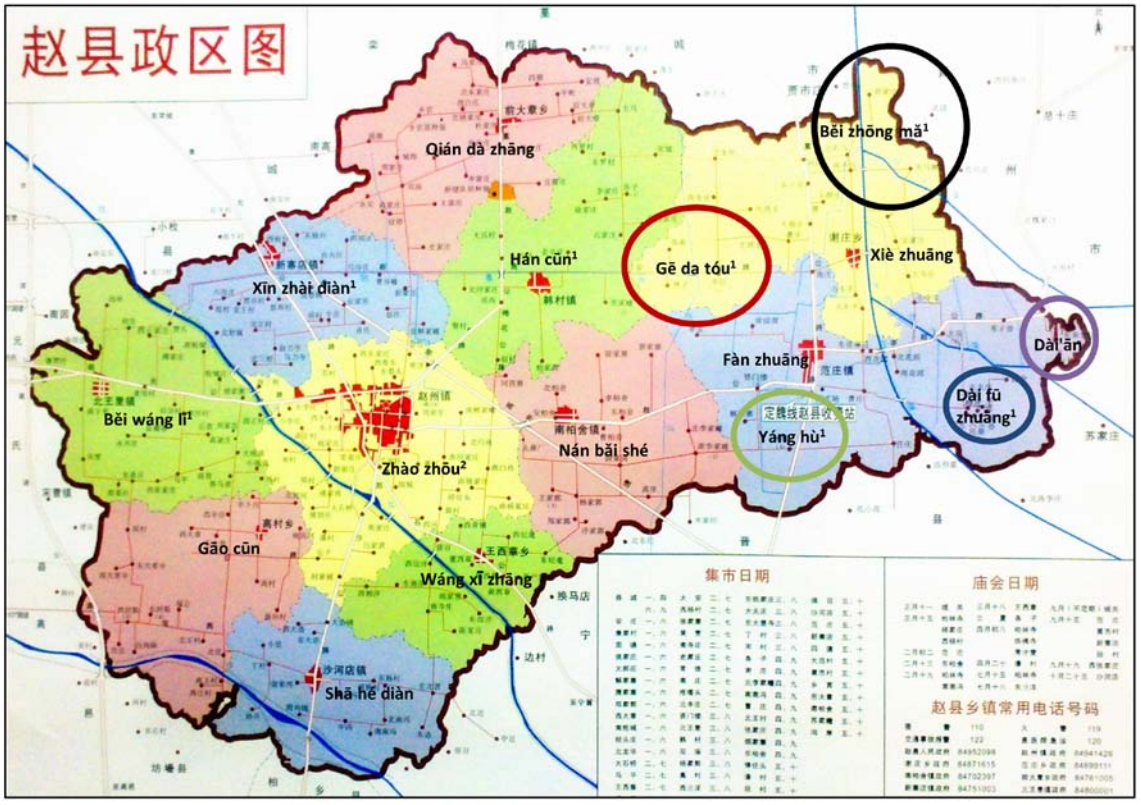


Figure 1. Map of Zhào County 赵县. The map shows 11 coloured areas. For the nine townships on the left side of the map, these nine areas correspond with the nine townships: Běi wáng lǐ 北王里 (green left upper area), Gāo cūn 高村 (red left middle area), Shā hé diàn 沙河店 (blue left lower area), Xīn zhài diàn 新寨店 (blue middle upper area), Zhào zhōu 赵州 (yellow central area), Wáng xī zhāng 王西章 (green middle lower area), Qián dà zhāng 前大章 (red left upper area), Hán cūn 韩村 (green right upper area), Nán bǎi shé 南柏舍 (red right lower area). However, the two areas on the right side of the map correspond with seven townships: the two township areas (Xič zhuāng 谢庄 (yellow right upper area) and Fàn zhuāng 范庄 (blue right lower area)) and five townships that are marked with circles. The five circles correspond with the areas of the five townships and the names of the townships are written in the middle of the circles. Superscripts above the townships indicate when they are covered in survey 1 or in the remaining study. Townships for survey 1: Hán cūn 韩村 (green right upper area), Yáng hù 杨户 (around the green circle), Běi zhōng mǎ 北中马 (around the black circle), Běi wáng lǐ 北王里 (green left upper area), Xīn zhài diàn 新寨店 (blue middle upper area), Gē da tóu 圪瘩头 (around the red circle), Dài fū zhuāng 大夫庄 (around the blue circle). Township for remaining study: Zhào zhōu 赵州 (yellow central area). Figure is the courtesy of Shuyi Zhang, personal collection.

since 2010 because of the following reasons: (i) previous survey data indicated low quality of care for children and high levels of inappropriate feeding practices; (ii) few maternal and child projects had been implemented in the county over the past 20 years; (iii) the socioeconomic development of Zhao County is similar to Hebei Province, which is similar to the national average; and (iv) the Zhao County Health Bureau and Zhao County Maternal and Child Health Hospital showed strong willingness to support quality improvement and good cooperation in research projects.

In China, the administrative levels are national, provincial, prefectural city, county, township and village. Hebei province is located in the northern part of the North China Plain with an area of 190 000 km^2 (for comparison, the size of the UK is 250 000 km^2), bordering the capital city Beijing. Hebei Province has a total population of 70.3 million, of which the urban population accounts for 43.7% and the rural population accounts for 56.3%. Shijiazhuang City is the Provincial capital of Hebei Province and administers Zhao County, which is one of the 114 counties in Hebei Province. Zhao County covers an area of 675 km^2 and is located in the middle–south part of North China Plain, 40 km south of Shijiazhuang City [68]. Zhao County has 16 townships and 281 villages (ranging between 7 and 46 villages per township) [69]. The total population in Zhao County was 571 000, with 518 000 people (90.7%) living in rural areas in 2010. The female illiteracy rate was 3.76% in 2010 and the main ethnic group is Han (99.9%) in Zhao County (data from 2010 provided by the Zhao County Statistics Bureau, unpublished). The annual per capita net income of rural residents in Zhao County was ¥ 6464 (about £ 615, € 739, US$ 953), which was higher than the average for residents of Hebei province which was ¥ 5958 (about £ 567, € 681, US$ 879) in 2010 (close to the national average of ¥ 5919) [70,71].

Zhao County is known for its agriculture, including Xuehua "snowflake" pears, wheat and corn. There are a number of famous historical sites in the county: Zhao zhōu "Arch" (Anji) Bridge赵州桥, Tuóluónìjīng Tower 陀罗尼经塔, and Bailin (Cypress Grove) Temple 柏林禅寺 (Online Supplementary Document, Field site photographs) [69].

Health care structure in Zhao County

In China, there is usually a general hospital and a maternal and child health hospital at county level, one hospital in each township and one clinic in each village. All these health care facilities serve as primary health facilities where people can go to without referral [72].

Zhao County has four hospitals at county level including a public general hospital, a public maternal and child health hospital, a public traditional Chinese medicine hospital and a private general hospital. The county has 16 townships with each a public township hospital and 281 villages with each a village clinic. The government set that the basic public health services for maternal and child health care should mainly be provided at township level in this county. However, in practice women often seek this care at county or higher level hospitals [52]. Village clinics are privately–owned by village doctors who receive small subsidies from the government for providing public health services. Village doctors provide primary health care at village level and are trained and supervised by staff at township and county level [73,74]. Education and training of village doctors varies, but usually they have at least primary school or junior high school and short basic medical training. Village doctors live in the communities they serve and have a good relationship with villagers.

Specific townships in Zhao County for different parts of the study

Zhao County has the following 16 townships: Hancun, Yanghu, Beizhongma, Beiwangli, Xinzhaidian, Gedatou, Daifuzhuang, Zhaozhou, Fanzhuang, Nanbaishe, Daian, Qiandazhang, Gaocun, Xiezhuang, Wangxizhang and Shahedian. The different parts of the study took part in eight of these townships: one survey that was part of the mixed methods study, survey 1, took place in seven townships and all the remaining parts of the mixed methods and cross–over study took place in one other township.

Survey 1 was undertaken in January 2013 with caregivers in the following seven townships: Hancun, Yanghu, Beizhongma, Beiwangli, Xinzhaidian, Gedatou, and Daifuzhuang.

Survey 1 was part of a randomised controlled trial aiming to assess the effectiveness of infant feeding information sent via QQ (Tencent QQ), an instant messaging programme, in reducing anaemia prevalence (registered at China Ethics Committee for Registering Clinical Trials; registration number ChiECRCT–2012033). These seven townships were chosen for the QQ randomised controlled trial, because the other nine townships were not suitable. In those nine townships, other studies took place that could have introduced bias in the trial: in seven townships (Zhaozhou, Fanzhuang, Nanbaishe, Daian, Qiandazhang, Gaocun, and Xiezhuang) a study evaluating integrated management of childhood illnesses and in two townships (Wangxizhang and Shahedian) an mHealth study that aimed to evaluate the use of text messaging to monitor anaemia medication. In the seven townships included in survey 1, there were 107 villages, with an estimated total population of 206 600, under–five population of 12 700, and 3600 children aged 6–23 months [68].

All the remaining study parts for the mixed methods study and the cross–over study took place in Zhaozhou Township from January to March 2013. The nine townships that were excluded for survey 1 were eligible for the remaining study parts, because the two previously described studies finished in 2012. Of those nine townships, Zhaozhou Township was chosen, because this is the largest township with 46 villages and an estimated under–five population of 4170, and it has both an urban and rural population [68].

METHODS

In this section we described the methodology of the two studies by which we aimed to advance mHealth methodology: the first study aimed to explore factors influencing the sample size of mHealth–based health surveys and the second study aimed to determine the validity of an mHealth text messaging data collection tool.

Study 1: Factors influencing sample size calculations for mHealth–based health surveys, a mixed methods study

Overview of methods. The aim of the first study was to explore factors that influence sample size calculations for mHealth–based health surveys and used mixed methods, both quantitative and qualitative. The methods of this study were described in three parts (**Figure 2**).

Part 1 described two surveys aiming to explore general characteristics of caregivers in Zhao County and their use of mobile phones in general and for health care; survey 1 was done with participants of the QQ randomised controlled trial (briefly described in the field site section) and survey 2 with participants of the cross–over study (described in the second part of this methods section). Part 2 described semi–structured interviews with caregivers about their general use of mobile phones and use for health care, semi–structured interviews with village doctors about recruitment of caregivers for the cross–over study and interviews with participants of the cross–over study about mHealth survey data collection methods. Part 3 described researchers' views on mHealth survey data collection in China.

By combining quantitative and qualitative data from caregivers, village doctors and researchers, we aimed to provide an in–depth understanding of factors influencing sample size calculations in different stages of mHealth–based health surveys. The results of this study will be presented elsewhere, and in the sections below we described in detail the methodology. We structured the study parts according to the methodology used and started by describing the methods for the surveys in the section part 1: surveys [75], then the methods for the three different interviews in the section part 2: interviews [76], and finally how we combined these with views from researchers' in the section part 3: researchers' views.

Figure 2. Overview of mixed methods study. Photographs are the courtesy of Michelle Helena van Velthoven and Wei Wang, personal collections.

Part 1: Surveys. The first part of the mixed methods study described two surveys: (i) a survey with participants of the QQ randomised controlled trial and (ii) a survey with participants of the cross–over study. The surveys aimed to explore general characteristics of caregivers in Zhao County and their use of mobile phones in general and for health care.

1. Sample: The first survey was part of a baseline survey for the QQ randomised controlled trial (see field site section). We calculated that a sample of 816 had sufficient power for the main outcome of this trial, which was anaemia prevalence. We calculated that a sample size of 408 children aged 6–23 months in the intervention and 408 in the control group (816 children in total) was sufficient to show a between–group difference for all key indicators, with 80% power and a 5% significance level. We assumed an anaemia prevalence of 61.4% and we aimed to detect a difference in the decrease in prevalence of 10% between the intervention and control group. Based on the national trends in anaemia prevalence (anaemia prevalence in children declines when they grow up), we expected the anaemia prevalence to decrease from 61.4% to 47.4% in the control group and from 61.4 to 37.4% in the intervention group.

Participants in the trial had to use the QQ program and we expected that 50% of caregivers used QQ. Therefore, we doubled the 816 participants that had to be included in the survey and we aimed for a sample size of 1632 participants. While the sample size calculation for the mHealth survey was not specifically calculated for mobile phone use indicators, the trial's sample size was more than enough to provide information on caregivers' mobile phone use. The seven townships had an estimated 3600 children aged between six months and two years on the name list (see field site section). We expected that an estimated 2400 caregivers (70%) on the name list were willing to participate and complete the survey, which was sufficient for the trial's sample size, even if fewer caregivers were willing to participate.

For the second survey with caregivers participating in the mHealth cross–over study, we aimed for a sample size of 1095 participants. This was described in the sample size section for the cross–over study in the second part of this methods section, because it required an explanation of the cross–over study design.

2. Participants: Survey participants were eligible for both surveys when they were a caregiver of a child aged between six months and two years. Caregivers were excluded if they had a child of a different age, if they were not willing to participate, or if they were unable to read or understand the informed consent materials. We gave caregivers a towel (worth ¥ 5, about £ 0.52, € 0.62, US$ 0.82) for their time to complete the face–to–face survey.

3. Recruitment: A doctor from Zhao County Maternal and Child Health Hospital (XS) was our local information person and helped us during the fieldwork. He had good connections with local people at different levels of the health care system and was experienced with health care research.

XS obtained a list with names of children in each village in the seven townships from the township hospital doctors. We decided to ask the village doctors to help us with recruiting caregivers in the village clinics, because many caregivers were familiar with their village doctor. Before the study started, village doctors were contacted on three occasions. First, the township hospital doctors contacted all doctors in the villages about the study and asked them to participate. Second, two days before the study started the township hospital doctors asked the village doctors when it was convenient to visit their villages, to check the township hospital name list, and to inform caregivers when they should come to the village clinic. The township hospital doctors informed XS during these steps. Third, half an hour before the interviewers arrived in the village, a township hospital doctor or XS asked the village doctor to start recruitment of caregivers.

We used a number of recruitment strategies to encourage caregivers to come to village clinics and these included the following: using loudspeakers in the villages, making phone calls to caregivers, visiting caregivers in their homes, asking caregivers to ask their neighbours, asking people on the street, going to places that caregivers visit, such as a market, and to gatherings of people such as a wedding. When possible, we used loudspeakers that were available in the villages and we asked the village doctor make the following announcement: "We are from the Capital Institute of Pediatrics and Zhao County Maternal and Child Health Hospital, if you are a parent of a child aged over six months and younger than two years, you can take the child to the village clinic, it is best if the mother comes, we will do a survey and then get a free test for anaemia, you can wait to get the result". For some of the villages, the hospital doctor was able to obtain a list of phone numbers from the local immunization service centre that we used to call caregivers. For other villages, the hospital doctor was unable to obtain this list as these villages belonged to an immunization service centre that was not willing to provide the phone numbers.

Village doctors were the main contacts for the recruitment of caregivers, because based on previous experiences we knew that caregivers were more willing to participate if their village doctor asked them. We expected that village doctors were familiar with all births in their village, because they reported newborns to the township hospital each month. Therefore, we expected them to be able to recruit a significant number of caregivers from their own records.

However, we anticipated that not all village doctors were willing to help us, but that they did not tell this to the township hospital doctor, XS or to us in advance. We expected that less willing or busy village doctors made fewer efforts to find caregivers of children on the name list. Therefore, we gave village doctors a small financial incentive for their efforts to increase their willingness to participate. For survey 1, we gave village doctors ¥ 50 per village (about ¥ 5.3, €6.2, US$8.2). For survey 2, we used a different approach to incentivize village doctors. We told village doctors that they received ¥ 50 for recruiting 55 caregivers, or fewer caregivers when their village had a smaller number of children under five. When village doctors recruited more caregivers, the amount they received increased with ¥ 10 (¥ 60 for 55–65 caregivers, ¥ 70 for 66–75 and so on).

When the interviewers arrived in the village clinics, they informed eligible caregivers about the study procedures, asked them to read the information sheet and gave them the opportunity to ask questions. The interviewers informed caregivers that the study results were not used to assess the health of their child, and that if they have any concerns about the health of their child, they should contact a health worker. Also, interviewers told caregivers that they could decide to withdraw from the study at any moment and that this did not influence the health care they received. Interviewers asked caregivers who were willing to participate if they understood what participation in the study included and to sign the informed consent form.

4. Interviewers: The supervisors for survey 1 (WW, YL, and BL) and survey 2 (WW and XD) were all experienced in supervising surveys in Zhao County. For both survey 1 and 2, the interviewers were medical students from local universities. The supervisors trained the students thoroughly on survey techniques the day before the study started. The training included: introduction to the survey aims, obtaining informed consent, use of a smartphone for recording the answers, a detailed explanation of every question, and practising interviewing. The students practised with a partner in pairs through role play and discussed their experiences with the whole group. The supervisors carefully monitored the students, gave constructive comments, and validated the students asking of questions. We tested the students at the end of the training; two supervisors played as actors, one took the role of an interviewer and another took the role of a caregiver. The supervisors were experienced in role–play and we used this as the "gold standard". The supervisors asked all students to record what the "caregiver" answered with a smartphone provided for the study. The supervisors compared the recorded data of all the students with the "gold standard".

For survey 1 with caregivers participating in the randomised controlled trial, there were a total of 347 questions in our survey instrument and the overall agreement for all questions for all the students was more than 97%.

The results of the training for second survey with caregivers participating in the mHealth cross–over study was described in the interviewers section in the second part of this methods section.

5. Data collection: Interviewers used a smartphone to record answers of caregivers to the survey questions in the village clinics with reasonable privacy. We validated smartphone data collection for the Chinese maternal, newborn and child health (MNCH) survey in Zhao County; compared to pen–and–paper data collection, smartphone data collection can avoid data recording and entry errors, has a similar interrater reliability and takes the same amount of time per interview [50]. The first survey was carried out by three teams of interviewers; there were two large groups of ten interviewers and one smaller group of seven interviewers (27 interviewers and 3 supervisors in total). Data collection for the second survey with caregivers participating in the mHealth cross–over study was described in the data collection section in the second part of this methods section.

6. Questionnaires: Survey 1 consisted of an identification, mobile phone, QQ and household module (Online Supplementary Document, Survey 1 on demographics and mobile phone use – English version and Survey on demographics and mobile phone use – Chinese version). We selected demographic questions from the identification and household modules of the World Health Organization's (WHO) MNCH Survey. We adapted questions from these modules to the local context in Zhao County and used them in previous research [50]. The questionnaire for the QQ randomised controlled trial included additional questions for the identification, QQ and household modules and four other modules relevant to the trial.

For the second part of the survey, a researcher fluent in English (MV) developed the mobile phone related questions in discussion with the Chinese researchers (YZ, YL, and WW) and an mHealth expert (JC). Then two Chinese researchers (WW and YL) translated the mobile phone related questions independently from English into Chinese (Mandarin). They compared the translations and disagreements were discussed with a third Chinese researcher (YZ). Then, a bilingual (Chinese and English) translator (EC) checked whether the meaning of the translated questions was comparable between Chinese and English. We tested the mobile phone questions with caregivers Zhaozhou Township and made minor changes in the questions to ensure that the questions were understandable and appropriate.

Survey 2 (see Online Supplementary Document, for the English and Chinese versions of Survey 2 on demographics and mobile phone use) was a simplified and slightly altered version of survey 1. We selected the most important survey questions to reduce the workload for interviewers and participants. The questionnaire for the cross–over study included two other modules relevant to the study.

7. Data management: When interviewers completed the face–to–face questionnaire, the data was wirelessly and securely uploaded into an Excel database via an internet server. The data was also saved on the memory card of the smartphone as an encrypted file. The data could only be decrypted with special software. The supervisors collected the smartphones at the end of each field work day. They returned the smartphones cleared from the data that was entered during the previous day to the interviewers in the morning. Only the supervisors were able to enter databases, and no changes could be made to databases. Each participant was given an identification number and the databases with participant information linked to the identification numbers could only be accessed by the researchers. We anonymised data for analysis and reporting.

8. Data analysis and outcomes: We used SPSS version 16.0 [77] for the statistical analysis of the quantitative data. We calculated proportions, medians (Q2), 25 (Q1) and 75 (Q3) percentiles for the demographic, and mobile phone use indicators. We did not impute missing data.

Part 2: Interviews. The second part of the mixed methods study described three types of interviews: (i) semi–structured interviews with caregivers about their general use of mobile phones and use for health care, (ii) semi–structured interviews with village doctors about recruitment of caregivers for the cross–over study, and (iii) interviews with participants of the cross–over study about mHealth survey methods.

1. Methodological orientation and theory: For all the interviews, we used thematic analysis [78], which is a method for identifying and analysing themes within data. We aimed to provide a rich thematic description of the entire data set that reflected the important themes. As an alternative to thematic analysis, we considered using grounded theory, which is a useful method for investigating an under–researched area [79]. We felt that grounded theory was the most appropriate analysis approach for our research, because there was no literature on the research topic and we were interested in knowing caregiver's perspectives and experiences. However, due to fieldwork and time constraints, a thorough grounded theory analysis was not feasible. Therefore, we chose a thematic analysis and used principles of grounded theory where possible. We used an inductive or bottom coding method by which the themes identified had to be strongly linked to the data themselves, which was somewhat similar to a grounded theory approach. We used a realist approach which assumes that motivations, experience and meaning are directly related to language. This allowed reporting meaning and experiences in a straightforward way.

2. Sample size: In *semi–structured interviews with caregivers,* we aimed for the sample size to be large enough to cover the diverse views of caregivers and to reach saturation of themes. Saturation is reached when no new themes emerge from the interviews. Between 12 and 60 interviews is generally enough [80] and saturation is commonly reached within 20 interviews [81]. Initially we planned to interview 15 to 20 caregivers. We analysed data from the first round of 15 to 20 interviews and used the saturation principle to determine the final number of participants. Additional interviews were held if saturation was not reached within the first 15 to 20 interviews.

We selected villages in semi–urban and rural Zhaozhou Township for recruitment of participants. We aimed to select the sample based on characteristics that we considered to be relevant: type of caregiver, age, number of children, urban or rural residence, education and type of mobile phone (low–end mobile phone or smartphone). Also, we aimed to look for dissonant cases to gain insights from people who were unusual in some way. We used snowballing and asked participants if they knew any other caregivers who were able to participate.

In *semi–structured interviews with village doctors*, we conducted semi–structured interviews with village doctors who participated in the cross–over study. We used a similar approach for the semi–structured interviews with village doctors as the approach that we used for the interviews with caregivers. We planned to interview between 10 and 20 village doctors (out of the 46 village doctors in total). We aimed to obtain a variety of views from village doctors and we selected both female and male village doctors from different villages. We recruited them based on their willingness to participate and the available time that interviewers had when they visited villages during the cross–over study.

In *interviews with caregivers participating in the mHealth cross–over study*, we undertook interviews with participants of the cross–over study within one week after completion of the cross–over study. We interviewed three groups of participants of the cross–over study: (i) participants who completed the text message survey; (ii) participants who responded to at least one text message question; and (iii) participants who did not respond to any text message questions. We aimed to interview 50 participants in each group. We anticipated that 50% of the participants who we asked were willing to participate. Therefore, we randomly select-

ed a sample of 100 participants for each group. We considered that participants who completed the text messaging part of the study may have been more likely to participate in the interviews. However, we also considered that participants who did not complete the text messaging part could have been more willing to answer a phone call than respond via text messaging. Therefore, we did not adjust the numbers and we used a similar number of participants for each group.

3. Participants and recruitment: In *semi–structured interviews with caregivers*, all interview participants were eligible if they were a caregiver of a child younger than five years of age and used a mobile phone. Two days before the study started, the Maternal and Child Health Hospital doctor asked the village doctors when it was convenient to visit their villages. When we arrived in the village clinic, we asked village doctors to find caregivers that were willing to participate. We used an approach similar to the surveys for obtaining informed consent and we explained caregivers the aims of the semi–structured interviews.

In *semi–structured interviews with village doctors*, we included village doctors that participated in the cross–over study. We excluded village doctors who were not willing to participate. The supervisors asked village doctors to participate when they visited villages during the cross–over study.

In *interviews with caregivers participating in the mHealth cross–over study*, we recruited caregivers for the cross–over study and this was described in detail in the sections "participants" and "recruitment" in the second part of this methods section.

4. Interviewers and data collection: In *semi–structured interviews caregivers*, a native female Chinese researcher (YL) did the semi–structured interviews with caregivers in Chinese. A female researcher fluent in English (MV) with experience in qualitative research was present during the interview to help YL and to record any non–verbal communication and observations. MV trained YL on qualitative research, which included an explanation of qualitative methods and interview techniques (eg, how to ask open–ended questions), and practice with team members and caregivers in Zhao County. MV made several visits to China and visited Zhao County so that she had an understanding of the Chinese research context.

YL aimed to summarize her understanding of what the caregiver said two times during the interview to verify her understanding of the caregiver's views. YL translated parts of the interview content several times during the interview to allow MV to ask additional questions. The use of an interpreter was not feasible as there was no person in the research team who was a native speaker both in Chinese and English. However, the use of an interpreter may have been less desirable as this could have influenced the flow of the interview. The researchers reflected after each interview and at the end of each fieldwork day, and recorded ideas. The interviews were carried out at a neutral and private location that was comfortable for the participants, often the participants' home, or if that was not possible, a quiet room in the village clinic. We asked participants if we could interview them alone and if they could ask their family members and other people not to disturb us during the interview. When the participant gave permission, the interview was recorded with a digital recorder, notes were taken to record non–verbal communication and photographs were taken of the caregiver and child (with face not identifiable and with their verbal and written permission). The interviews took between 15 and 60 minutes. We did not carry out repeat interviews with the same participants to go further into depth, because this was not feasible.

In *semi–structured interviews with village doctors*, the two female supervisors in the cross–over study (WW and XD) conducted the semi–structured interviews with village doctors' interviews in Chinese. MV trained WW and XD on qualitative research, but did not take part in the interviews. The interviews were carried out at a neutral and private location that was comfortable for the village doctor, usually a quiet room in the village clinic. When the village doctor gave permission, the interview was recorded, and notes were taken to record non–verbal communication. The supervisors and MV reflected after the interviews and noted ideas.

In *interviews with caregivers participating in the mHealth cross–over study*, we used telephone interviews and face–to–face interviews for the interviews with caregivers participating in the cross–over study. The two supervisors of the cross–over study (WW and XD) interviewed the second group of participants (those who responded to at least one text message question) face–to–face, because they were able to do this during the fieldwork. In this group, the supervisors also asked participants if they could check the mobile phone of the participant to confirm whether they received text messages (when the same person participated face–to–face and via text messaging and brought their mobile phone). We conducted telephone interviews with participants in the first group (those who completed the text message survey) and third group (those who did not respond to any text message questions), because we could not interview these participants face–to–face. Four team members (WW, XD, YL, and QW) conducted the telephone interviews. They called participants at a time convenient for participants and when the phone call was unanswered, they called participants back up to three times. The interviewers used a pen–and–paper questionnaire to record the interview.

5. Questionnaires: All the interview guides were developed in a similar way as the mobile phone questions in the survey. In addition, we asked a Chinese sociologist (YQ) for advice for the semi–structured interviews with caregivers. We used probing questions (asking open–ended questions; questions starting with how, why, what etc.) to follow–up on the questions in the guide, because an in–depth understanding of topics usually comes from probing [82].

In *semi–structured interviews with caregivers*, we did not define specific research questions at the start of the interviews, but we had initial broad research questions. The initial aims of the interviews were to better understand: (i) how caregivers use their mobile phones and (ii) what caregivers' experiences were when using a mobile phone for seeking health care (Online Supplementary Document, Topic guides for semi–structured interviews with caregivers, Topic guide 1). Halfway the interviews we felt that we reached saturation on these aims and we refined the questions into the following: (i) which factors influence whether caregivers respond to text messages and (ii) what caregivers' experiences were with seeking information for their child's health via their mobile phone (Online Supplementary Document, Topic guides for semi–structured interviews with caregivers, Topic guide 2).

In *semi–structured interviews with village doctors,* the aim of the interviews was to better understand willingness of village doctors to recruit caregivers. The interview guide (Online Supplementary Document, Topic guide for semi–structured interviews with village doctors) included questions around how village doctors found it to recruit caregivers for the mHealth cross–over study. We had the following research questions: (i) how many caregivers were village doctors able to find, (ii) what motivated them to find caregivers, and (iii) what they thought that influenced caregivers' willingness to come to the clinic.

In *interviews with caregivers participating in the mHealth cross–over study*, the aim of the interviews was to explore factors that influence participation of caregivers in mHealth studies. We made three specific questionnaires for the three different groups of participants (Online Supplementary Document, Questionnaires for interviews with caregivers participating in the mHealth cross–over study). The questionnaire included open–ended questions about how caregivers found it to reply to text messages and which method of answering questions they preferred. Also, the questionnaire included closed–ended questions for which we asked participants to respond with a number, such as how many text messages caregivers were willing to answer at most on a day.

6. Data management: In *semi–structured interviews with caregivers and village doctors*, local students transcribed the recorded data verbatim in Word 2007. These transcriptions were checked by students and rechecked by the same person who conducted the interviews by listening to the tapes. We kept the recorded data and transcripts on a secure computer and anonymised all the data. We sent transcripts to participants and asked them to return them, because the interviewer summarized her understanding of what the participants said during the interviews.

In *interviews with caregivers participating in the mHealth cross–over study*, two students transcribed the pen–and–paper form in an Excel database and a Chinese team member (YL) compared the data and completed the final database. Any discrepancies were addressed by discussing this with a team member (XD).

7. Data analysis and outcomes: In *semi–structured interviews with caregivers*, we used computer–aided qualitative data analysis software MAXQDA 11 to analyse the qualitative data (VERBI Software – Consult – Sozialforschung GmbH; Berlin, Germany). The interviews with caregivers were transcribed in Chinese and translated into English, because the team member fluent in English (MV) was involved in the fieldwork and analysis. The Chinese interviewer (YL) conducted the analysis in Chinese and MV did the analysis in English. To obtain the transcripts in English, YL translated the transcripts from Chinese into English. A second Chinese team member (WW) checked the translations and MV checked the English language and discussed the meaning of the transcripts with YL. Then YL analyzed the data in Chinese and MV analysed the data in the English.

We conducted our thematic analysis in six steps. First, two researchers read through the interviews several times in an active way (searching for meaning) to obtain an overview of the interview data. Second, initial codes were given to findings (units of texts). We coded for as many possible findings as possible (including context), gave full and equal attention to each data item and kept data which was different from the main story. The two researchers compared their coding after each interview. Third, we searched for themes (group of codes that are similar and capture something important about the data) and sorted codes into potential themes. New themes were added until no new themes emerged from the findings. We only looked for semantic (explicit) level themes; we did not look beyond what a participant said. The two researchers carried out this process independently and discussed their findings. Fourthly, we reviewed the themes on two levels: of the coded data extracts and in relation to the data set. We reviewed coded data extracts and constantly compared them in relation to the data set to consider validity of the themes. We continued reviewing this until we had a good idea of what the themes were, how they fitted and the overall story of

the data. Fifthly, we defined and named themes. Sixthly, we related the different themes to each other to develop an explanation in relation to the research question [83], we choose vivid quotes which captured the essence of key points and we wrote the "story" (analysis).

YL translated the Chinese themes into English and MV compared these with the English themes. The bilingual translator (EC) translated the final English version of the themes back into Chinese and compared them with the original Chinese themes [84]. Throughout the analysis, we kept memos to capture our thought processes. We compared our fieldwork memos and observations with the analysed data. We discussed the analysis within the research team and with a qualitative researcher and Chinese sociologist (YQ) to verify the understanding of the interpretation. We did not ask participants for feedback, because this was not feasible in this research setting. We presented a narrative of the main findings.

In *semi–structured interviews with village doctors*, we used an approach similar to the one that we used for the semi–structured interviews with caregivers. However, there was one important difference; these interviews were done by two Chinese researchers (XD and WW) and also analyzed by two Chinese researchers (YL and XD) in Chinese. After analyzing the data in Chinese, YL and XD independently translated the themes into English. They compared the two Chinese–English translations and discrepancies were solved by consulting a third Chinese team member (WW). EC translated the final English translation back into Chinese and compared with the original Chinese concepts [84].

In *interviews with caregivers participating in the mHealth cross–over study*, we used Excel version 2010 for the analysis of the interviews with participants of the mHealth cross–over study. We calculated proportions and medians (Q2) with 25 (Q1) and 75 (Q3) percentiles for the questions where the interviewers categorized the response of the caregiver and for questions where a number was asked.

For the open–ended questions, we did a simplified version of a thematic analysis, because telephone interviewing allowed less for in–depth probing. Two Chinese researchers (YL and WW) independently read through the data several times, identified the main themes in the data and summarized the results in Chinese. The approach for translation of the results was similar to the approach for translation of the results of semi–structured interviews with village doctors. We presented a narrative of the main findings.

Part 3: Researchers' views. Researchers kept a log book during the fieldwork to capture ideas about factors influencing sample size calculation for mHealth–based health surveys. A team member (MV) wrote a narrative of these notes and all researchers involved in this project contributed their views. The views were compared with the analysis of the surveys and interviews and the findings were added to the narrative.

Study 2: Comparison of text messaging vs face–to–face interviews for health surveys, a cross–over study

Overview of methods. The aim of the second study was to determine the validity of an mHealth text messaging survey data collection tool. We used a randomised cross–over study design to compare the traditional face–to–face survey method to the new text messaging survey method (**Figure 3**). We randomised participants per village into two groups: group 1 first completed the face–to–face survey and then the text message survey, and for group 2 this order was reversed. Participants were caregivers taking care of a child younger than five years. We compared 17 questions on care–seeking for childhood diarrhoea and pneumonia signs and symptoms that we selected from the WHO MNCH household survey. The text messaging survey had two additional questions (19 questions in total): the first question asked about the agreement of the caregiver to participate

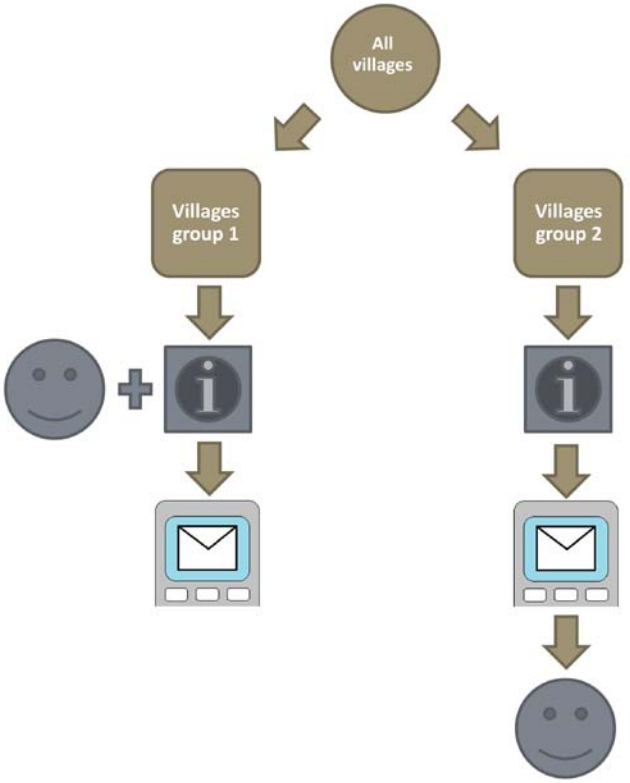


Figure 3. Design of randomised cross–over study. Letter clipart indicates informed consent and collection of demographic and mobile phone use information; face clipart indicates interviewer–administered face–to–face survey on childhood diarrhoea and pneumonia; mobile phone clipart indicates self–administered text messaging survey on childhood diarrhoea and pneumonia. Images were created in Microsoft PowerPoint 2010 or Paint.

and the second question asked about the relationship between the caregiver and the child. In addition to those two questions on agreement and relationship, participants had to answer a minimum of four text message questions about disease symptoms (diarrhoea, fever, cough, fast or difficult breathing). Depending on whether their children had these symptoms, we asked participants one or more of the 13 follow–up questions. We compared responses of caregivers between the face–to–face and text messaging methods and evaluated how similar responses were by data equivalence (intrarater agreement) and the amount of information for the open–ended questions in text message 13 and 20 (places where care was sought), and participants' reasons for differences. We analysed the overall response rate (proportion of completed interviews), item response rate (the proportion of responses for each question) differences between responders and non–responders, and the error rate of the text messaging method. We described the detailed methods of the cross–over study in the sections below and the results will be presented elsewhere (unpublished).

1. Sample size: We were unable to conduct a sample size calculation for the cross–over study, because we did not have accurate estimates from previous research that could inform a calculation. Therefore, we estimated a rough number of participants that we could recruit in the study setting (**Figure 4**). We aimed to include 1095 participants from Zhaozhou Township; 516 participants in group 1 and 579 participants in group 2. Zhaozhou Township had an estimated under–five population of 4170 children according to a name list provided by the township hospital. Based on previous experiences, we expected that 70% of caregivers approached participated, that 40% responded to at least one text message, and that 10% responded to a reminder text message (about 46% responded to either a text message or reminder). We expected to recruit 516 caregivers for group 1 based on these expected proportions; if we approached 1600 caregivers for group 1, 1120 participated face–to–face, 448 responded to at least one text message and 68 responded at least once after a reminder text message. For group 2, we expected that more participants dropped out, because a second visit to the clinic was required for the face–to–face interview. Therefore, we oversampled the number of caregivers that we planned to approach in group 2. We expected to recruit 828 caregivers for group 2; if we approached 2570 caregivers, 1800 agreed to participate, 720 responded to at least one text message, 108 responded at least once after a reminder text message, and 579 participants who responded to at least one text message also participated in the face-to-face interview.

2. Randomisation: We used stratified randomisation, taking into account the size of the village, to divide villages into two groups. The aim of stratified randomisation was to avoid imbalances in baseline characteristics as the caregivers fell into obvious strata (the size of the village). Individual randomisation could have introduced bias, because participants from two groups living in one village could then have shown each other the text messages. This could have influenced the responses they gave and thereby have biased the results. Also, we could not randomise participants on an individual level for fieldwork organisational reasons; it was very difficult to double the number of visits to villages and at the same time keep the time interval between recruitment and the surveys the same (we visited caregivers in villages in group 1 once and caregivers in villages in group 2 twice and this was on set days to keep the time interval the same).

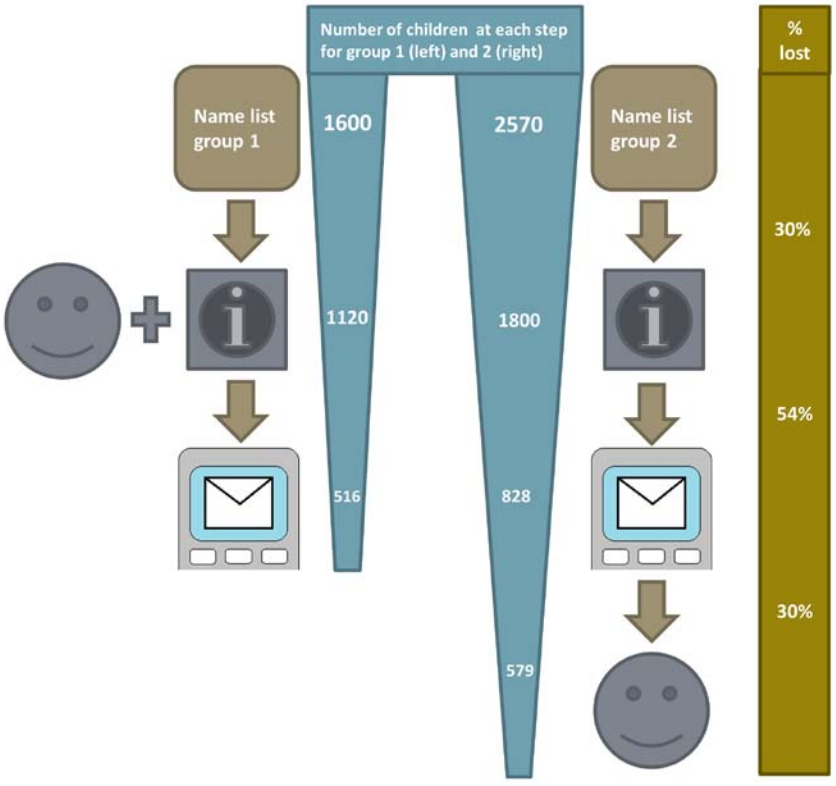


Figure 4. Rough estimation of the expected number of participants of cross–over study. Letter clipart indicates those expected to complete informed consent and collection of demographic and mobile phone use information; face clipart indicates those expected to complete interviewer–administered face–to–face survey on childhood diarrhoea and pneumonia; mobile phone clipart indicates those expected to complete at least one question from self–administered text messaging survey on childhood diarrhoea and pneumonia. Images were created in Microsoft PowerPoint 2010 or Paint.

The villages had an estimated under–five population ranging between 20 and 335 children. As this population size per village was highly variable, we had to take the size of the village into consideration to prevent major imbalances in the groups. We did not have the option of randomising the villages according to a particular characteristic, because we did not have any information available. We used SAS version 9.2 (SAS Institute Inc, Marlow, UK) for the randomisation and we ranked villages based on their under–five population sample size into three strata of 15, 15 and 16 villages each. We chose a small number of strata, because we needed to ensure a sufficient number of individuals in each stratum. An independent statistician provided us with a list of random numbers to determine the strata that had 16 villages. The ranking meant that the size of the village was randomly used for allocation to one of the strata. For example, if stratum 1 had the smallest villages, stratum 2 had the medium sized villages, and stratum 3 the largest villages. Then we randomised the villages in each stratum into group 1 or group 2; we gave a random number to each village and assigned villages to the groups. We used block–randomisation with a ratio of 1:1.6 to allocate a larger proportion of participants to group 2 and to account for the expected higher drop–out (see sample size section).

3. Recruitment: We used a similar strategy for recruitment as we described in the section "surveys" in the first part of this methods section. We made the following announcement: "We are from the Capital Institute of Pediatrics and Maternal and Child Health Hospital in Zhao County. We are doing a survey of children and we will ask you about your child's health in the past two weeks. If you are a parent of a child younger than five years, come to the village clinic around: *appropriate time*. You have to be able to receive and send text messages to participate. You do not need to bring the child, because we do not do physical examination. After the interview, you will get a towel to thank you for your time and effort to participate."

4. Participants: Caregivers were eligible if they took care of a child younger than five years of age, used a mobile phone and were able to send a text message. Caregivers were excluded if they were not willing to participate, if they were unable to read or understand the informed consent materials, if they did not have a mobile phone, or if they could not sent a text message. Based on our previous experiences, we knew that many grandparents were unable to text message and therefore we did not actively recruit grandparents. However, as many grandparents take care of the child(ren) of their son and some of them can text message, we also considered them for eligibility. We checked with care whether grandparents were able to text message. We asked them to send us a test message in which they had to write the name of their grandchild or spell the "immunization card" (five Chinese characters, spelled 预防接种证).

We gave caregivers a towel (worth ¥ 5, about £ 0.52, € 0.62, US$0.82) for their time to complete the face–to–face survey. We gave caregivers who participated in the text messaging survey ¥ 5 for completing the text message survey, and we paid back the costs of the text messages (sending a text message in China costs ¥ 0.1, about £ 0.01, € 0.1, US$ 0.2) by mobile phone credit payment within a week. We told caregivers that they received ¥ 0.1 per text message that they sent. However, for the payment we had to pay a minimum of ¥ 1 to each participant as the mobile payment could not be less than that. We also paid ¥ 1 to participants who responded "not willing" to the first question and we paid ¥ 5 to participants who almost completed the survey (the last question required a second text message response after a prompting question, but some participants responded only once to this last question; however, they may have felt that they completed the survey). The payment was made before the interviews aiming to explore reasons for not responding to text messages (see sections on "interviews with caregivers participating in the mHealth cross–over study").

We informed caregivers in the first group that they were asked to participate in the text messaging survey the day after the face–to–face survey. We informed caregivers in the second group that they were asked to participate in the text messaging survey two days after signing the informed consent and that they had to visit the village clinic again in four days to complete the face–to–face survey.

5. Interviewers: We performed face–to–face and text messaging surveys.

In the *face–to–face survey*, there were 14 interviewers for the face–to–face interviews: 10 undergraduate medical students from a local university, one postgraduate medical student, and two supervisors (WW and XD). After recruitment of participants in the first group, five students had to leave half way because of their studies and five new students were trained to interview participants in the second group. All interviewers were familiar with the dialect in Zhao County, which is slightly different from standard Chinese. The supervisors were experienced child health survey researchers who had done previous surveys in Zhao County.

During the training, we calculated inter–observer agreement, the proportion of agreement for each question between students and intra–observer agreement, the proportion of agreement for each student. There were a total of 50 questions and 100 variables (answer options) in our survey instrument. For the first round, the intra–observer agreement for all questions for eight students was more than 96%. Two students scored lower, for one it was 77% and for one 83%, because they misunderstood the prin-

ciple of skipping some of the questions. Therefore, we explained the questions with wrong answers to the two students, and did the validation test again. Then the agreement increased to 98% for both students. The inter–observer agreement was 95% for the first round and 98% for the second round. For five students who replaced the five students that had to leave, the intra–observer reliability was more than 96% and inter–observer reliability was 98%. To further optimize the reliability, we discussed and explained all questions that posed problems and provided help to students who needed assistance. The supervisors checked whether each student was doing the survey correctly during fieldwork. The supervisor stood next to the interviewer and participant during the whole process on the first day for every interviewer.

In the *text messaging survey*, one researcher (YL, based in Beijing) sent the text messages and a second researcher (first QW, then by two trained students) checked the text messages. The first researcher trained the second researcher by giving an introduction to the study, explaining the algorithm and checking the text messages. To ensure that the second researcher understood the procedures, the initial checks that the second researcher did were rechecked by the first researcher. Any problems or inconsistencies were addressed appropriately.

We used a Chinese text message system (Shāng jī bǎo 商机宝) for sending text messages to participants and receiving text messages from them. We chose the best system based on experiences with three Chinese text message systems. We tested the chosen system during pilots and a previous study (unpublished). We checked the text messaging system for incoming response text messages (Online Supplementary Document, Description of sending text messages). We exported all the incoming text messages into an Excel file and prepared the appropriate follow–up text messages by following a protocol. This procedure could not be done automatically by the text message system. To prevent errors from occurring in this process, the second researcher checked the text messages that the first researcher prepared before they were sent. In case there was disagreement or confusion, a third researcher (MV) was consulted for advice.

6. Questionnaires: The questionnaire in the *survey on demographics and mobile phone use*, was described in the questionnaires section for the first study in this methods section.

In the *face–to–face and text messaging questionnaire on care–seeking for childhood diarrhoea and pneumonia*, we selected 17 questions from the diarrhoea module and cough and fever module (used to assess pneumonia) from the WHO's MNCH Health survey. The child health survey experts from the Capital Institute of Pediatrics (YZ, LC, QW, YL and WW) translated the questions into Chinese, adapted them to the local context in Zhao County, tested the questions during pilot research and used them in large household surveys in 2010 and 2011 (unpublished data).

The text message survey included the same 17 selected questions from the diarrhoea and cough and fever modules that we used for the face–to–face survey. Of those 17 questions, 3 questions (10, 13, and 20) had follow–up questions (10a, 13a, and 20a). In addition, the text message survey had two additional questions: the first question asked about agreement to participate and the second question asked about the relationship between the caregiver and the child. In addition to the two questions on agreement and relationship, participants had to answer a minimum of four text message questions about disease symptoms (diarrhoea, fever, cough, fast or difficult breathing). Depending on whether their children had these symptoms, participants had to answer one or more of the 13 other questions.

We adapted the questions to make them fit into the text messages in an interdisciplinary team of child health (IR) and child health survey experts (YZ, LC, QW, YL and WW). During the development of the text message survey, we aimed that the text message questions had the same meaning as the face–to–face questions (Online Supplementary Document, Detailed description of development of text messaging survey). The adaption process included a local terminology study on diarrhoea and pneumonia signs and symptoms (Online Supplementary Document, Local terminology study) and cognitive interview study on understanding of the text message questions by caregivers (Online Supplementary Document, Guide for cognitive interviews). We used the final face–to–face and text messaging survey questions for the study (see Table S6 in Online Supplementary Document).

In the *questionnaire on reasons for different responses*, the questionnaire (Online Supplementary Document, Questionnaire for interviews about reasons for different responses) included two questions to help the participant think about why they gave a different answer. The third question, "Why do you think the answer you gave for this question via text message is different from the response you gave face–to–face?", had the following answer options: misunderstood text message question, misunderstood face–to–face question, changed mind, put wrong answer in text message, gave no response to text message question, or other.

7. Data collection: We addressed the schedule of the fieldwork and procedures for data collection.

Fieldwork schedule: In group 1, first the interviewers obtained informed consent and interviewed the participants face–to–face on the demographic, mobile phone use and care–seeking for childhood diarrhoea and pneumonia; then after one day the text messages were sent. The one–day pe-

riod between the surveys was a balance between memory and recall issues. This period was introduced so that participants were likely to have forgotten their answers, but still had a similar survey 2–week recall.

In group 2, on the first day we obtained informed consent, asked participants the demographic and mobile phone use questions and informed participants that they received text messages after 2 days. On the third and fourth day, the text message survey took place. There were two days between the informed consent and the first text message for logistical reasons, because the follow–up interviews could not coincide with the recruitment days (it was not feasible to do both recruitment and follow–up interviews on the same day). On the fifth day, we visited villages for the second time to ask the survey questions face–to–face. We sent a text message to participants and asked them to come to the clinic for the face–to–face interview on care–seeking for childhood diarrhoea and pneumonia. We only asked participants who responded to the first diarrhoea module question to participate in the face–to–face interview, because we aimed to compare the text messaging and face–to–face responses.

Procedures: In the *face–to–face survey on demographics and mobile phone use*, the interviewers administered the demographic questions and mobile phone use after participants signed the informed consent. They paid special attention to correctly recording the mobile phone numbers of participants, because it was essential for the study to have the correct mobile phone numbers. The interviewers called the participants on the mobile phone number they provided to validate the number (if the participant brought a mobile phone). Interviewers recorded responses of participants with a smartphone.

In the *face–to–face survey on care–seeking for childhood diarrhoea and pneumonia*, interviewers also recorded responses to the diarrhoea module and cough and fever module of participants with a smartphone. As required for the face–to–face interviews, the interviewers did not give the answers to participants, but selected the most appropriate answer based on the participant's response.

In the *text message survey on care–seeking for childhood diarrhoea and pneumonia*, we sent the first text message (introduction text message which did not require a response) at 9 AM in the morning and the second text message that asked about their willingness to participate directly after the first text message. We called participants who responded that they were not willing to participate and asked for their reasons. If the reason was that they misunderstood the question, we gave an explanation and asked them to reply again. When a participant was willing to participate, we sent the third text message with a question about the identity of the participant. We checked whether the identity of the participant was identical to the identity of the person who signed the informed consent and who participated in the face–to–face interview. When the identity was different, we called the mobile phone number and the person answering the phone was asked for their identity. If the person was related to the child on the name list, we asked the person to encourage the person who signed the informed consent and participated face–to–face to reply to the text messages.

The researcher sent the first survey question to all participants who were willing to respond and who were the same caregiver that participated face–to–face. First, we sent questions from the diarrhoea module; this included text messages 4 to 13. Second, we sent the cough and fever module; this included text messages 14 to 20. When we received a response to the text message question, we sent the appropriate follow–up question until the text message survey was completed. We followed the survey algorithm for sending the appropriate follow–up questions. Depending on the condition of the child, certain questions had to be answered or could be skipped. When participants completed the survey, then we sent an end text message and thanked participants for their cooperation. We sent text messages till 9 PM in the evening (Online Supplementary Document, Descriptions of sending text messages).

Participants were required to respond with an answer in Chinese characters. The answer options of the questions were provided in the text messages, because previous research showed that not giving participants the answer options resulted in unclear answers. We considered asking participants to reply with a number, but this was inconvenient and some participants ignored our request. However, this meant that we anticipated some unclear answers.

When a text message was empty we sent the following response: "your text message is empty" followed by the text message with question. When an answer phrase was unclear we sent the following text message: "there is a problem with your text message, please respond again" followed by the text message with question. When there was a question from the participant, we called the participant. When participants said that they did not want to continue, we sent them the following text message: "We are sorry to hear you want to discontinue, you will not receive text messages from us anymore. Thank you for participating." and stopped sending text messages.

The number of the text messaging system contained 16 numbers (1065–5059–1091–1763). This was a special number, because normal Chinese mobile phone numbers have only 11 digits without area codes. We checked the functionality of the text messaging system during the fieldwork. We asked the text message system company for a report of successfully sent text messages. Also, every morn-

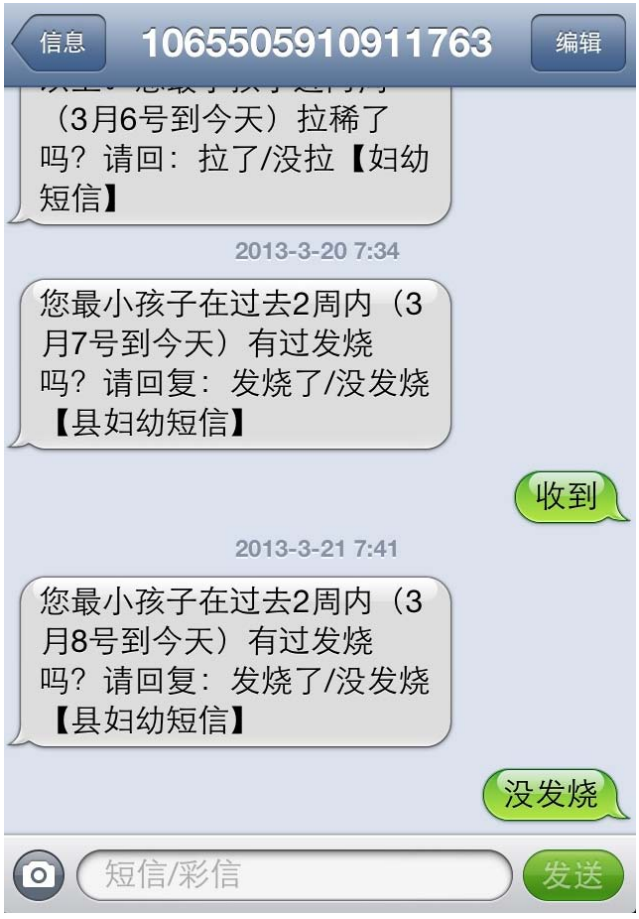


Figure 5. Screen shot of mobile phone. A screen shot of a supervisor's mobile phone when testing sending of text messages in the morning before the fieldwork of the cross–over study started. The shot is courtesy of Xiaozhen Du, personal collection.

ing before sending text messages, we sent text messages to eight mobile phone numbers of researchers in our team, which included the three major telecom operators in China, China mobile, China Unicom, and China Telecom, and asked them to reply (**Figure 5**). If we did not receive their reply, we made phone calls to the researchers to confirm whether they had received a text message.

In *interviews on participants' reasons for differences in responses*, at the end of the face–to–face interviews in group 2, we asked participants who participated in both the text messaging and face–to–face interview structured questions about reasons for giving a different response when comparing the face–to–face and text messaging answers. Before the face–to–face interview, the first text messaging researcher (YL) sent the responses of the text messages to the supervisors in the field (WW and XD). Directly after the face–to–face interview, the interviewers compared the responses to the face–to–face questions and text message question and marked differences in responses. The supervisors conducted the interviews and recorded one of the different answer options with pen–and–paper.

8. Data analysis and outcomes: We used SPSS version 16.0 [77] and SAS version 9.2 for the statistical analysis of the quantitative data. We compared characteristics between groups 1 and 2 with the Pearson chi–square test and Fisher Exact Test for nominal variables and Mann-Whitney U/ Wilcoxon W test for not normally distributed continuous variables and ordinal variables. We considered *P* values less than 0.05 significant. We present data from the diarrhoea and cough and fever questions for all participants in group 1 and for those who returned to the village clinic and completed the modules in group 2. We did not impute missing data.

Data equivalence and the amount of information: We assessed data equivalence (intrarater agreement); the degree to which the responses to the face–to–face questions and text messages were identical [85]. Kappa is a useful statistic for measuring agreement and to test measurement equivalence [86]. Cohen's kappa can be used to indicate the strength of agreement for a nominal scale used on separate occasions [87]. Cohen's kappa compares the observed agreement with agreement that is expected by chance alone, which makes it a chance–corrected index of agreement. A kappa value of 0 means that there is no agreement beyond chance, while a kappa value of 1 indicates that there is perfect agreement. There is no accepted standard for rating the different values for kappa. Kappa values higher than 0.60, 0.70 or 0.80 are generally considered to be the minimum standard for group–level comparisons or for research purposes. However, these strengths of agreement do not indicate the practical relevance of results. There are a number of interpretations, which all are arbitrary [88,89]. We used the Landis and Koch [88] interpretation, because it has the most detailed description of agreement: <0.00 poor, 0.00–0.20 slight, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 substantial, and 0.81–1.00 almost perfect.

Disagreements between different ratings are not equally important for ordinal data. To account for this, Cohen introduced weights for the calculation of a weighted kappa [90]. Weighted kappa takes account of the distance between disagreements and is therefore appropriate for ordinal scales with more than two categories. There are different weights given to kappa, but the most commonly used ones are the Cicchetti–Allison [91] and Fleiss–Cohen weights [92]. Fleiss–Cohen gives quadrant weights and can be similar to the intraclass correlation coefficient [92,93]. Cicchetti–Allison gives linear weights and is more appropriate for questions with many answer options [94]. The linearly weighted kappa coefficient can be simply derived from K–1 embedded 2x2 classification tables [95]. Our survey included two ordinal questions, with five answer options. The value of weighted kappa is sensitive to the

choice of weights [96]. As the number of answer options was relatively high, Cicchetti–Allison was the most appropriate choice for the weights. However, also this is arbitrary and therefore we presented both Fleiss–Cohen and Cicchetti–Allison weights.

Our survey on care–seeking for childhood diarrhoea and pneumonia included 17 questions that could be compared between the two methods: (i) 10 questions with a nominal scale (dichotomous "yes" or "no" answers); (ii) 5 questions with a nominal non–dichotomous scale for which we calculated kappa values when possible; and (iii) 2 questions with an ordinal scale (answers varying from "none" to "more") for which we calculated weighted Cicchetti–Allison and Fleiss–Cohen weights kappa values. We calculated the results for group 1 and 2 combined and compared of kappa values and 95% confidence intervals (CI) for the two groups separately.

In addition, we analysed the amount of information by the number of places caregivers reported for question in text message 13 and 20 (places where caregivers sought care) by comparing the number of places given between the face–to–face method and the text message method.

We reported a combination of kappa statistics (including kappa values, 95% CI, *P* values) and the percentage of agreement, which allowed for a detailed impression of data agreement [97]. For the proportion of agreement, we did not present the proportion when the number of participants was less than ten.

Participants' reasons for differences in responses: We calculated proportions for the reasons for differences between face–to–face and text messaging responses.

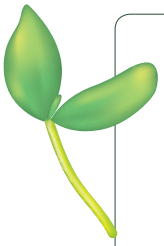
Item response rate and overall response rate: We defined item response rate as the proportion of participants responding to each question and the overall response rate as the proportion of participants who completed the text messaging survey. For the proportion of participants completing the survey, the number of questions participants had to answer depended on the responses that they gave to questions about the condition of their child. There were five conditions that determined the questions participants had to answer: diarrhoea, complementary feed, fever, cough and fast or difficult breathing. We created 24 "statuses" that represent all combinations of these 5 conditions. We calculated the number of participants completing each of the 24 different statuses. However, we could only calculate the proportion of participants that completed the entire survey for all of the 24 different statuses combined. We could not calculate proportions for each different status, because participants who did not reply did not provide information on their status, and therefore could not be classified.

Characteristics of responders vs non–responders: In group 1 we compared responders with non–responders for the first question and for the complete survey. We used the same tests as we used for the comparison of characteristics between group 1 and group 2.

Error rate of the text messaging method: We evaluated the error rate of the text messaging method by incorrect text message questions that we sent and incorrect text message answers that we received from participants. For the face–to–face method, this was not relevant, because the smartphone was programmed to avoid errors. The smartphone guided the interviewer through the interview and when a value was missing or out of range, the interviewer could not continue the survey without entering a valid response. However, despite our efforts to minimize errors in the text messaging survey, this could not be eliminated due to the manual process of sending text messages. We defined incorrect questions sent as text messages that were not sent or not sent in the right format because of researcher errors. We defined incorrect text message answers as responses of the participants that were empty, unclear, or out of range and that had to be assessed, and those that needed a follow–up text message. We presented an overview of the text messages sent and received with proportions of incorrect text message questions sent and answers received.

CONCLUSION

This paper described the objectives, field site and methods of a large mHealth project that is part of collaboration between researchers in China and the UK. The mixed methods study evaluating factors that influence sample size calculations could help future studies with estimating reliable sample sizes. The cross–over study comparing face–to–face and text message survey data collection could help future studies with developing their mHealth tools.



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Ethical approval: The Ethical Committee of the Capital Institute of Pediatrics in Beijing gave ethical approval for the study. The cross–over study was a comparison study, which did not assess the effects of an intervention and therefore the study was not registered with a trial registry.

Authorship declaration: MV designed the study and drafted the article. YL, WW, XD, QW, LC, AM, IR, YZ and JC made a substantial contribution to conception and design of the study and revised the article critically for important intellectual content.

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PAPERS

mHealth Series: Factors influencing sample size calculations for mHealth–based studies – A mixed methods study in rural China

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Background An important issue for mHealth evaluation is the lack of information for sample size calculations.

Objective To explore factors that influence sample size calculations for mHealth–based studies and to suggest strategies for increasing the participation rate.

Methods We explored factors influencing recruitment and follow–up of participants (caregivers of children) in an mHealth text messaging data collection cross–over study. With help of village doctors, we recruited 1026 (25%) caregivers of children under five out of the 4170 registered. To explore factors influencing recruitment and provide recommendations for improving recruitment, we conducted semi–structured interviews with village doctors. Of the 1014 included participants, 662 (65%) responded to the first question about willingness to participate, 538 (53%) responded to the first survey question and 356 (35%) completed the text message survey. To explore factors influencing follow–up and provide recommendations for improving follow–up, we conducted interviews with participants. We added views from the researchers who were involved in the study to contextualize the findings.

Results We found several factors influencing recruitment related to the following themes: experiences with recruitment, village doctors' work, village doctors' motivations, caregivers' characteristics, caregivers' motivations. Village doctors gave several recommendations for ways to recruit more caregivers and we added our views to these. We found the following factors influencing follow–up: mobile phone usage, ability to use mobile phone, problems with mobile phone, checking mobile phone, available time, paying back text message costs, study incentives, subjective norm, culture, trust, perceived usefulness of process, perceived usefulness of outcome, perceived ease of use, attitude, behavioural intention to use, and actual use. From our perspective, factors influencing follow–up were: different caregivers participating in face–to–face and text message survey, sending text messages manually, participants responding incorrectly, and technical issues. Participants provided several recommendations for improving follow–up and we added our views to these.

Conclusions This is the first study to evaluate factors influencing recruitment and follow–up of participants in an mHealth study in a middle–income setting. More work is needed to assess effectiveness of our suggested strategies. This work would improve evaluation of mHealth interventions.

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mHealth, or mobile health, has the potential to improve the delivery of health care and improve health worldwide. However, there is limited thorough mHealth evaluation and thus insufficient evidence to implement and scale–up effective mHealth interventions [1,2]. An important issue for mHealth evaluation is the lack of information for sample size calculations. Sample size calculations are influenced by both recruitment and follow–up of participants. When the sample size targets are not met, this can lead to an underpowered study in which differences between groups are statistically non–significant. Extending the recruitment period increases costs and introduces logistical issues. In addition, when the number of participants who are recruited is low and loss to follow–up is high, the risk of selection bias and retention bias is considerable, which limits generalizability of results [3].

Problems with recruitment and retention are common; a review of 73 randomised controlled trials reported that only 40 (55%) achieved their original recruitment target [4]. A systematic review of 45 randomised controlled trials that used activities to improve recruitment found the following strategies successful: telephone reminders to non–responders, use of opt–out rather than opt–in procedures for contacting potential participants, and open designs where participants know which intervention they receive [5]. A systematic review including 28 population–based cohort studies of interventions to improve retention of participants found that incentives, reminder letters or call, and alternative data collection modes demonstrated a benefit [6]. However, while reporting of recruitment and follow–up of participants in studies has been improved by checklists, such as CONSORT for randomised trials, reporting is still often not described with sufficient level of detail [7].

mHealth–based studies face specific difficulties with reaching their target sample size. mHealth interventions are complex in their nature as technology interacts with health system designs and people. Selection bias occurs when a large number of people do not use mobile phones and when consent–rates are low. Despite the ubiquity of mobile phones in low– and middle–income countries, there may be differences in use by gender, age, education and income [8,9]. Individual mHealth data collection has shown to face several challenges [10]. Effective follow–up is particularly important for studies that use text messaging [1] as text message data collection studies have reported variable response rates [10–21]. We had little information available to calculate an accurate sample size when conducting our mHealth data collection studies on child health in Zhao County, rural China.

Mobile phones are commonly used in both urban and rural China and the Chinese government has introduced many text messaging public health education programs, including programs for child health [22]. However, there have only been a few mHealth studies in China and the applicability of mHealth to the Chinese health care system has not been assessed [22]. China has a three–tier health care system with usually a general hospital and a maternal and child health hospital at county level, one hospital in each township and one clinic in each village [23]. Health workers in township hospitals are the main provider of antenatal and postnatal care, and vaccination [24]. Almost all women deliver in the township or county hospital and health workers record names of caregivers and their children after birth [25]. Township and county level health workers train and supervise village doctors [26,27]. Village doctors provide general primary health care at village level, including some maternal and child health care. Education and training of village doctors varies, but usually they have at least primary school or junior high school and short basic medical training. Village doctors live in the communities they serve and have a good relationship with villagers.

This study was part of a larger mHealth project and in the first paper of this mHealth series, we described the aims of the project, field site in China, and methodology [28]. In the current paper, we aimed to explore factors that influence sample size calculations for mHealth–based studies and to suggest strategies for increasing the participation rate. We used our experiences with recruitment and follow–up of participants in an mHealth text messaging data collection cross–over study. Generic lessons can be learned from our experiences and they will help future mHealth studies with estimating their sample sizes.

METHODS

Overview of methods

Recruiting and following up participants in an mHealth data collection cross–over study was challenging (methodology described in the first article in this mHealth series) [28]. We used a mixed methods design with the purpose of explaining our findings from the cross–over study [29]. We aimed to explore factors influencing recruitment and follow–up and to suggest strategies to improve participation.

In this methods section, we started with a brief description of the cross–over study. Then we described the process of recruitment, number of caregivers recruited, and methods for evaluating recruitment. Finally, we described the process of follow–up, number of participants followed up and methods for evaluating follow–up.

Cross–over study

In the cross–over study, we randomised caregivers of children under five at village level into group 1 and group 2. The aim of the cross–over study was to determine the va-

lidity of an mHealth text messaging survey. We compared the traditional face–to–face survey method to the new text messaging survey method. The study took place in Zhaozhou Township, Zhao County, Hebei Province, China in March 2013. The detailed characteristics of the sample of participants and results on the outcomes of the cross–over study will be reported elsewhere (unpublished).

Recruitment

Process of recruitment. The Zhaozhou Township hospital and four affiliated vaccination clinics provided a list of names (referred to as the "name list") with names of children and their caregivers, children's date of birth and sometimes phone numbers of caregivers in Zhaozhou Township. We asked township hospital and county hospital doctors to contact village doctors and to arrange a time for recruitment. Village doctors were asked to gather in their village clinic all caregivers of young children who lived in their village. Initially, we asked village doctors to use their own list with names of caregivers for gathering caregivers (we thought that they had their own name list), but they did not have their own name lists. Therefore, we gave village doctors the name list, and asked them to validate the names.

Before we arrived in the village, we asked village doctors to make an announcement with loudspeakers when possible. In addition, we asked village doctors to make phone calls to caregivers and to go to caregivers' houses to invite them if no phone numbers were available. We visited villages during the day and late afternoon to recruit parents who were working during the day (we were unable to go to villages in the evening). We also asked caregivers to notify their neighbours, we asked people on the street and we went to places that caregivers visited.

We provided village doctors a small compensation (¥ 50, about Ł 5.3, € 6.2, US$ 8.2, for recruiting 55 caregivers) for their efforts. When village doctors recruited more caregivers, the amount they received increased with ¥ 10 (¥ 60 for 55–65 caregivers, ¥ 70 for 66–75 and so on). As recruitment was challenging, we decided to visit villages in group 1 for the second time to recruit caregivers (this was not possible in group 2). For the second visit, we increased the incentive to ¥ 10 for every four caregivers village doctors recruited.

We included caregivers who had a child younger than five, used a mobile phone and were able to text message. We gave a towel (worth ¥ 5, about £ 0.52, € 0.62, US$ 0.82) to caregivers for participating in the face–to–face interview. In addition, we found during the fieldwork that caregivers were interested in child health information and we provided a health information calendar that we developed in a previous study in 2012 [30].

Number of caregivers recruited. The name list had 4170 children under five at the time of the study. We randomised 16 villages with 1600 children under five into group 1 and 30 villages with 2570 children under five into group 2 (our study design required more children to be allocated to group 2). To estimate the number of caregivers of children we would be able to recruit, the only estimate we had available was recruiting 70% of caregivers for previously conducted household surveys. Taking this 70% into account, we would be able to recruit and include 2920 caregivers in 46 villages (1120 participants in group 1 and 1800 in group 2). However, we only recruited 1026 caregivers in 42 villages and we had to exclude 12 caregivers for the following reasons: the child of one caregiver just reached the age of five, we did not send text messages to three caregivers in group 1 because of an administrative mistake, and we could not identify which child belonged to the text message responses for eight caregivers (which we only realized after the study). Those eight caregivers were four caregivers who gave the same mobile phone number as four other caregivers (they belonged to only four different families and gave one phone number per family). Therefore, of the 4170 names of children on the name list, we included 1014 (24%); 371 in group 1 and 643 in group 2.

Evaluation of recruitment. We conducted semi–structured interviews with village doctors who recruited participants and we added our views. The detailed methodology of the interviews was described in the first paper in this mHealth series [28].

Data collection. Two trained female researchers (WW and XD) conducted the interviews in Chinese at the end of the second visit to villages (the aim of this visit was recruitment in villages in group 1 and follow–up in villages in group 2). The interviews were carried out in a quiet private room in the village clinic. When the village doctor gave permission, the interview was recorded, and notes were taken to record non–verbal communication. We used probing questions (open–ended questions; starting with how, why, what etc.) to follow up on the questions in the interview guide [31].

Sample. We included ten village doctors who recruited participants, seven males and three females. The village doctors were from six different villages in group 1 (Table S3 in Online Supplementary Document) and from four different villages in group 2 (Table S4 in Online Supplementary Document). Their age ranged between 29 and 63 years and all completed a secondary school.

Data analysis. We used thematic analysis [32] and aimed to provide a description of the entire data set that reflected the important themes in the interviews. Two Chinese researchers (YL and XD) analysed the data in Chinese and independently translated the main findings into English, compared them and through discussion developed the

English translation of the main findings. The findings were discussed and further analysed with help of a researcher fluent in English (MV). A bilingual translator translated the main findings from English back into Chinese, we compared this with the original Chinese and revised the English where needed [33]. In addition, we added our own views and experiences to the themes that we found in the interviews. We clearly identified which views were from village doctors and which views were ours.

Follow–up

Process of follow–up. In group 1, our interviewers obtained informed consent from caregivers and administered the face–to–face survey in the village clinic. A day after the face–to–face interview, we sent participants the text messages survey questions (which participants could answer at a place of their convenience). In group 2, interviewers obtained informed consent in the village clinic and then we sent participants the text messages. We asked caregivers who responded to at least the first survey question in text message 4 (question about whether the child had diarrhoea in the past two weeks) to visit the village clinic again for the face–to–face survey the day after the text message survey ended.

The face–to–face and text messaging survey both had 17 overlapping questions on care–seeking for childhood diarrhoea and pneumonia signs and symptoms that we compared between the methods. The face–to–face survey had additional questions on demographics, the household and mobile phone use. The text messaging survey had three follow–up questions and two additional questions: one on agreement to participate and one on the relationship between the participant and the child. In the face–to–face survey, trained interviewers recorded participants' answers with smartphones [34]. In the text message survey, we manually sent text messages to participants using a Chinese text message system [28]. The number of the text message system contained 16 digits (1065–5059–1091–1763). This was a special number, because normal Chinese mobile phone numbers have only 11 digits.

For the face–to–face survey, as reported in the recruitment section, we gave a towel and health information calendar to participants. For the text message survey, we paid back the text message costs to all participants who responded and provided ¥ 5 if participants completed the text message survey. We gave participants two days to respond to the text message questions. We sent two reminder text messages (nine and 24 hours after the first text message). We sent text messages and made phone calls to participants in group 2 who had to return to the village clinic for the face–to–face interview.

Number of participants followed up. Of the 1014 participants in the cross–over study, 662 (65%) responded to the first text message question about willingness to participate in text message 2. A total of 538 (53%) responded to the first survey question in text message 4 (question used for data equivalence sample size calculation), which was less than the 56% response rate we assumed. A total of 356 (35%) participants completed the text message survey (we could not estimate how many participants would complete the survey).

In group 1, of the 371 participants who were interviewed face–to–face, 233 (63%) responded to text message 2, 189 participants (51%) responded to text message 4 and 137 participants (37%) completed the text message survey. In group 2, of the 643 participants who provided informed consent during the first visit, 429 (67%) responded to text message 2, 349 participants (54%) responded to text message 4, and 219 (34%) completed the survey. We invited the 349 participants who responded to text message 4 to come to the village clinic for the face–to–face interview and assumed 70% to come, but 302 (87%) came. Even an additional five participants came who had not responded to text message 4 (we had not asked them to come).

Evaluation of follow–up. We interviewed participants who did not respond to the text messaging survey (referred to as "non–responders"), participants who responded to text message 2 but did not complete the text message survey (referred to as "non–completers"), and participants who completed the text message survey (referred to as "completers"). In addition, we described our experiences with follow–up. We asked participants for their recommendations to improve follow–up and added our views to these. We provided a detailed description of this methodology in the first paper in this mHealth series [28].

Data collection. We interviewed participants via telephone interviews and face–to–face. The two supervisors of the cross–over study (WW and XD) interviewed non–completers in group 2 when they returned to the village clinic for the face–to–face interview. In the week after completing the fieldwork, we conducted telephone interviews with completers and non–responders in both groups, and non–completers in group 1, because we could not interview these participants face–to–face. Four team members (WW, XD, YL, and QW) conducted the telephone interviews. They called participants at a time convenient for participants. When the phone call was unanswered, they called participants back up to three times. The interviewers used a pen–and–paper questionnaire to record the interview. The interviews were structured and we combined closed–ended and open–ended questions (with follow–up probing questions). We asked non–responders for their views on the text messaging method and non–completers and completers for their views on the face–to–face and text messaging methods.

Samples. We used simple random sampling with SAS version 9.2 (SAS Institute Inc, Marlow, UK) to select random samples of non–responders, non–completers, and completers. We randomly selected 125 non–responders out of 352 non–responders. We could not reach 57 non–responders, we reached 68 non–responders and we included 62 non–responders: 55 mothers (89%) and 7 fathers (11%). We had to exclude six non–responders: four did not want to participate and two quit before giving an answer to the first question. We randomly selected 93 non–completers out of 306 non–completers. We could not reach 35 non–completers and we included 58 non–completers who answered questions: 42 mothers (72%), 12 fathers (22%), 2 grandmothers (3%) and 2 grandfathers (3%). Of those 58 included non–completers, 56 finished the interview and two non–completers quit the interview before the end, but gave answers to questions. We randomly selected 110 completers out of 356 completers. We could not reach 37 completers and we included 73 completers: 58 mothers (80%), 13 fathers (18%), 1 grandmother (1%) and 1 grandfather (1%). Of those 73 completers, 68 finished the interview and six caregivers quit the interview before the end, but answered questions.

Data analysis. We calculated proportions for the closed–ended questions. We conducted a thematic analysis for the open–ended questions. Two Chinese researchers (YL and WW) independently read through the data several times, identified the main themes in the data and summarized the main results in Chinese. The approach for translation of the results was similar to the approach for translation of the results of semi–structured interviews with village doctors.

During analysis of the qualitative data, we found that our themes had overlap with variables in the Technology Acceptance Model [35] and modified versions of this model [36–39]. Therefore, we organized our data according to variables in these models. The Technology Acceptance Model proposes that a person's acceptance of a technology is determined by its perceived usefulness and perceived ease of use [35]. The model predicts that ease of use and usefulness will influence a person's attitude toward, intention to use, and acceptance of the technology. Consequent factors of perceived usefulness and ease of use are attitude, behavioural intention to use, and usage. In our context, perceived usefulness was participants' perception that the survey methods enhanced the process of participation in the study and that participation had a useful outcome. Perceived ease of use was a participant's perception that the survey methods were free of effort. Additional variables proposed in modified models are variables that influence perceived ease of use or usefulness. These variables depend on the context, and include prior usage, gender [40], trust, perceived financial costs [41], culture [42] and subjective norm [39]. Subjective norm is an individual's perception of the degree to which important other people approve or disapprove of behaviour.

RESULTS

Overview of results

First, we described factors influencing recruitment and recommendations for ways to recruit more caregivers based on interviews with village doctors and on our own experiences. Second, we described factors influencing follow–up and recommendations for improving follow–up based on interviews with non–responders, non–completers, and completers, and on our own experiences.

Recruitment

We provided a summary of village doctors' and our views on factors influencing recruitment and ways to recruit more caregivers; a detailed description can be found in Online Supplementary Document.

Factors influencing recruitment. We found several factors influencing recruitment related to the following themes: (i) experiences with recruitment, (ii) village doctors' work, (iii) village doctors' motivations, (iv) caregivers' characteristics, and (v) caregivers' motivations.

Experiences with recruitment. Generally, we did not have problems with reaching villages, but road problems did not allow us to visit one village for the second recruitment round in group 1. Although we carefully organised our fieldwork, it was difficult to reschedule when there was a problem. Most village doctors were available to help us with gathering caregivers, but when they were not helpful this often resulted in only finding a small number of caregivers. Some village doctors said that they did everything they could to recruit caregivers, while others said that because participation in the study was voluntary, they helped but did not do their best. Village doctors were able to recruit more caregivers when the name list and phone numbers of caregivers were available. Village doctors did not have their own name list, so we relied on the name list from the township hospital. The township name list was not accurate, because children on the list did not always seem to live in villages and we found children who were not on the name list of villages. The township hospital had phone numbers of caregivers for a number of villages and in addition some village doctors had phone numbers of caregivers they knew. However, it was common that there were mistakes in the phone numbers due to wrong recording, or phone numbers were no longer in use. Many parents were not home during the time that we visited the villages (during the day), while grandparents were often home and

took care of children. Village doctors said that our study selection criteria made it harder for them to recruit caregivers. Most village doctors used the villages' loud speaker to gather caregivers and found this convenient. Some village doctors also made phone calls to caregivers and we called caregivers when village doctors were not able to do this. Only few village doctors visited caregivers' houses, because this was time–consuming and they did not always know where caregivers lived. Other recruitment methods included going on the street and to places where caregivers often came, and asking caregivers to notify others. The effectiveness of the different strategies depended on the specific context of the village.

Village doctors' work. Village doctors' work included treating patients and selling medicines. We found that village doctors also did other work to increase their income. Some village doctors had their own village clinic, while others shared their clinic with other village doctors. At the time of our study (March), village doctors were not busy and mainly worked in the morning and evening. Village doctors had previous experiences with recruiting caregivers for vaccination or had participated in our previous studies.

Village doctor's motivations. Village doctors did not always understand the aim of the research well and sometimes found it not useful. Village doctors did not experience delays in their normal work, but during busy times in the year, they would not participate when the study interfered with their work. Village doctors often said not to mind about the compensation we provided for their time, but in our experience some did mind. Other motivations were that village doctors wanted to work for villagers, follow orders from hospital doctors and cooperate with our research team.

Caregivers' characteristics. Caregivers were often busy with work and did not have time to participate when they had to earn their income. Village doctors thought caregivers' education was not always sufficient to understand the survey questions, but in our experience most caregivers were able to understand our questions. Parents could usually text message, but grandparents could often not.

Caregivers' motivations. Township hospital doctors' explanation of the research was not sufficient to inform village doctors well. Many village doctors did not have a good understanding of the study. Thus, village doctors did not seem to explain the study well to caregivers when asking them to come to the village clinic. Caregivers did not always understand why they had to come, and found it not useful when their child was not ill. When we explained the study to caregivers when they were in the village clinic, still village doctors thought that many caregivers did not understand the aim well. However, we found that most caregivers understood what we were doing. Village doctors felt that caregivers found it difficult to trust us, because caregivers were concerned about being misinformed or deluded. Sensitive questions about income and expenses were perceived useless and caregivers did not understand why these had to be asked, because the study was about child health. Village doctors thought that many caregivers came for the reward (towel). We felt that caregivers were interested in good health information.

Recommendations for ways to recruit more caregivers. More caregivers could be recruited when the name list and phone numbers were given in advance. Village doctors said that if we would include all caregivers, then they would be able to recruit more caregivers, but this would not be feasible for text message studies. Village doctors thought that it would be better recruit caregivers earlier on the day, because then more caregivers had time. In addition, we think going to the villages in the evening may be a good strategy too. However, village doctors' and interviewers' working hours would have to be taken in consideration. Continuing to use the village's loudspeakers, make phone calls and send text messages to caregivers were recommended. Village doctors were willing to visit caregivers' houses when they had more time available, but this would be a time–consuming approach. Village doctors recommended giving caregivers more money than caregivers' could earn, but this would not be desirable and too costly. Another recommendation was to give a free health test for children, but we consider this only to be appropriate when this is required for a study. It was mentioned to bring a doctor who could give health information. We think that this may increase trust of village doctors and caregivers, but to provide health information, a more cost–effective solution may be to send health information text messages. Moreover, to address factors that negatively influenced recruitment, we suggest to develop and test new information materials for village doctors and caregivers, omit sensitive questions from survey and tailor recruitment strategies to the specific context of villages.

Follow–up

First, we described factors influencing follow–up. Second, we presented recommendations for improving follow–up.

Factors influencing follow–up. We described participants' views on factors influencing follow–up reported by non–responders, non–completers, and completers, followed by researchers' views.

Non–responders. **Table 1** shows the quantitative results of non–responders. Out of the total of 62 non–responders we interviewed, 43 (68%) recalled that they received a text message from us. Of those 43 non–responders, 27 (63%) said to have received a reminder text message. A total of 31 non–responders did not know or were not sure whether

Table 1. Non–responders' experiences with text messaging survey and reasons for not responding

	No. (%)
Received text message? (n = 62)	
Yes	43 (69)
No	11 (18)
Do not know	8 (13)
Received reminder? (n = 43; "yes" for "received text message?")	
Yes	27 (63)
No	7 (16)
Do not know	5 (12)
Missing (interviewer forgot to ask)	4 (9)
Reasons for not receiving text message (n = 31; "no" or "do not know" for received text message or reminder)	
Do not know (not related to their mobile phone)	10 (32)
Broken mobile phone	4 (13)
Did not check mobile	4 (13)
Software to block messages	3 (10)
Forgot what happened	3 (10)
Did not bring mobile	1 (3)
Text message box was full	1 (3)
Child played with mobile	1 (3)
Father used mobile	1 (3)
Missing (interviewer forgot to ask)	3 (10)
Reasons for not responding to text message question (n = 43)	
Did not have time	13 (30)
Did not bring the mobile phone	7 (16)
Mobile phone switched off	6 (15)
Did not know how to reply	5 (12)
Did not trust the text message	3 (7)
Did not see the text message	3 (7)
Did not have enough credit	3 (7)
Forgot to reply	1 (2)
Child deleted text message	1 (2)
Did not receive a new text message	1 (2)

they received a text message or reminder text message and we asked them for the main reason; most frequently mentioned was do not know (10; 32%), a broken mobile phone (4; 13%), or not checking the mobile phone (4; 13%). The main reasons of the 43 participants for not replying to text messages were as follows: did not have time (13; 30%), did not bring the mobile phone (7; 16%), or mobile phone was switched off (6; 15%).

Table 2 presents positive and negative views of non–responders on factors influencing follow–up of the text message survey. We found the following factors that had only negative views: mobile phone usage, ability to use the mobile phone, problems with the mobile phone, checking the mobile phone, available time, subjective norm, culture, trust, perceived usefulness of process, and attitude. There were both positive and negative views on perceived usefulness of outcome and ease of use. There were only positive views for actual use (it was mentioned to have replied, but it was too late to reply or we may not have sent a follow–up text message by a mistake).

The previously mentioned reasons for not receiving the text message or not responding were also mentioned when we asked further in–depth. While we selected participants based on their ability to text message, some said they could not reply to text messages. Additionally, non–responders said not to send text messages very often. Many reasons for not responding were related to having problems with the mobile phone or not checking the mobile phone. Some non–responders were too busy to respond, especially when the child was naughty. A mother said that the father did not let her reply or that he used her mobile phone. Another reason was being in "the sitting month"; in China traditionally women stay at home in the first month after delivery and have no contact with people outside the family. Trust was a frequently mentioned issue; the text messages were not trusted when the phone number was unusual or when we asked irrelevant questions in the face–to–face interview. Text messaging was perceived as not useful, because no questions could be asked and it took a lot of time to reply. The usefulness of the outcome of the study was perceived important and good for child health. However, some perceived the study not important when the aim of the study was not well understood. Not many views were related to perceived ease of use. Non–responders' attitude included not wanting to use the text message function for surveys and that it was less good than a face–to–face interview or phone call interview. Positive was that some non–responders had the intention to reply when they saw the text message and had time.

Non–completers. **Table 3** presents quantitative data on non–completers' views on the surveys. All 58 non–completers recalled to have replied to a text message that they received from us (100%). A total of 36 non–completers (62%) said to have received a reminder message. The most frequently mentioned reasons for not replying were that non–completers replied, but did not receive a new message (34; 59%), did not have time (10; 17%), or forgot to reply (7; 12%).

Qualitative data are presented in **Table 4** on the face–to–face and text messaging survey and in **Table 5** on study incentives. We found the following factors with only negative views: mobile phone usage, ability to use mobile phone, problems with mobile phone, available time, and trust. There were both positive and negative views on checking the mobile phone, study incentives, perceived usefulness of process, perceived usefulness of outcome, perceived ease of use, and attitude. There were only positive views on paying back text message costs and actual use (it was mentioned to have replied, but we may not have sent a follow–up text message by a mistake).

Non–completers were sometimes not used to the mobile phone or not used to sending text messages. In addition, they experienced some problems with their mobile phone. They did not always check their mobile phone, but could reply when they brought their mobile phone in their pock-

Table 2. Non–responders' positive and negative views on text messaging survey

Factor	Positive	Negative
Mobile phone usage		Do not send text messages very often Not used to sending text messages Do not have the habit of replying to text messages
Ability to use mobile phone		Cannot use mobile phone very well Cannot reply to text messages
Problems with mobile phone		Mobile phone was broken Did not have battery Did not have mobile phone credit Mobile phone signal is bad Text message box full Sending the text message failed Software to block text messages Child deleted text message, could not find it
Checking mobile phone		Did not check the mobile phone Did not pay attention Was asleep when receiving text message Was too late when seeing text message Did not see the text message Did not bring the mobile phone Did not have a ringtone for text message
Available time		Busy, do not have time Child was very naughty Had something to do at that time
Subjective norm		The child's father did not let mother reply Child was playing with mobile phone and father was not at home
Culture		Child's father used mobile phone In "sitting month"*
Trust		Did not trust it Did not trust it; there were irrelevant questions in face–to–face interview Thought that the phone number should be from Beijing, but text message said "Zhao County Maternal and Child Health Hospital"† Phone number was too long Thought it was a "trash" text message Worried about charging fees for text messaging
Perceived usefulness of process		A limitation of the method is that no questions can be asked It said to send reminders about raising a child, but these were not send to me It took a lot of time to reply The face–to–face and text message questions were the same
Perceived usefulness of outcome	It is important It is very good Good for child's health Want to make contribution to society	Did not think it was important, because the child did not have the condition that was asked Did not know why text messages had to be sent Did not understand why diarrhoea and pneumonia Did not matter whether reply was given or not Could not benefit from it directly
Perceived ease of use	Can talk in detail Can understand text messages	It was too much effort to reply Forgot to reply
Attitude		It is inferior to face–to–face or making phone calls Do not want to use text message function for surveys
Behavioural intention to use	Will reply when I see it Will reply if I have time	Did not really want to participate, but cannot say the reason clearly
Actual use	Did reply to text message Replied, but it was late	

*In Chinese culture, "sitting month" in brief or "zuoyuezi", literally means "sitting the first month after delivery" and restricts women from going out of their home or receiving visits from others.

†We explained caregivers that we were from the Capital Institute of Pediatrics in Beijing.

et. Both for the face–to–face and text messaging survey there were non–completers who said not to have time. Paying back ¥ 1 for the text messages was enough for 36 out of 58 non–completers (62%). Non–completers said that paying back the text message costs was good, but also mentioned not to mind about the money, because it was for the child's sake. However, more money was found to be better and if there were more questions, ¥ 1 would not be enough. As incentive, 42 out of 58 participants liked to receive health information (72%). Health information was found useful and important, because it could be used for a long time and there was a need for more information. In addition, health information was harder to obtain than the towel that we gave for the face–to–face interview or the ¥ 5 mobile phone credit (which we promised to give if non–completers responded to all text message questions). However, non–completers also mentioned that they did not mind about the incentives and did not lack them. Non–completers found it hard to trust the text messages and concerns about privacy were raised, because we asked sensitive questions (about income and expenditure) in the face–to–face survey. Some non–completers only wanted to reply to questions about the child.

There were many comments related to perceived usefulness and ease of use. The face–to–face survey was perceived to

Table 3. Non–completers' experiences with and views on surveys (n = 58)

	No. (%)
Received text message?	
Yes	58 (100)
No	0 (0)
Received text message reminder?	
Yes	36 (62)
No	16 (28)
Do not know	5 (9)
Missing (interviewer forgot to ask)	1 (1)
Reasons for not responding to the text message question	
Did not receive a new text message	34 (59)
Did not have time	10 (17)
Forgot to reply	7 (12)
Did not have enough credit	3 (5)
Time reading text message was too late	2 (3)
Did not bring the phone	1 (2)
Concerned about privacy	1 (2)
Views on receiving ¥ 1 for text message costs	
Was enough	36 (62)
Was not enough	2 (3)
Did not mind	18 (32)
Missing (interviewee quit)	2 (3)
Preferred study incentive	
Health information	42 (72)
¥ 5 mobile phone credit	6 (10)
Towel (worth ¥ 5)	4 (7)
No preference	4 (7)
Missing (interviewee quit)	2 (4)
Preferred survey method	
Face–to–face	23 (40)
Text messaging	18 (31)
No preference	17 (29)

be more useful than the text messaging survey, because questions could only be asked during the face–to–face interview. Both methods were found time–consuming. However, a perceived benefit of the text messaging method was being able to respond at a self–chosen time. While some did not know what the aim of the text messaging survey was, others perceived the aim to be OK or good. It was found too much effort to participate in the face–to–face survey, because it required going out. There were some contradicting views on ease of use. For example, replying via text messaging was found both not much effort and too much effort, both easy and hard, and both convenient and inconvenient. The questions were found to be clear and detailed for both methods, but text message questions were also found to be unclear and mistakes were likely to happen via text messaging. Out of the 58 non–completers, 23 (40%) preferred the face–to–face survey method and 18 (31%) the text messaging method. When asked in–depth, many non–completers expressed to have no preference and that the methods were equally OK. However, non–completers also said that there were too many text messages.

Completers. **Table 6** presents the quantitative results of completers. Of the total of 73 completers we interviewed, 26 (36%) said to have received a text message reminder and the majority of them (24; 92%) found receiving one, two or three reminders OK. Nevertheless, still some completers worried about forgetting to reply. The time of receiving the text messages was acceptable for 48 participants (66%). The evening or afternoon was the most preferred time to receive text messages and 15 said that any time was OK (21%).

Qualitative data are presented in **Table 7** on the face–to–face and text messaging survey and in **Table 8** on study incentives. We found the following factors with only negative views: mobile phone usage, ability to use the mobile phone, and checking the mobile phone. There were both positive and negative comments for available time, study incentives, trust, perceived usefulness of process, perceived usefulness of outcome, perceived ease of use, and attitude. There were only positive views on problems with the mobile phone and paying back text message costs.

Although completers replied to all text message questions, limited text messaging usage and ability were seen as hindering factors when responding to text messages. Completers did not mention problems and had enough mobile phone credit to respond. Completers were not being able to reply immediately when they did not see the text message. Both for the face–to–face and text messaging survey there were completers who said to not have time for the interviews. It was hard to trust the text messages, because there were a lot of text messages that were perceived as deceiving, and thus no reply would be given to a strange number. However, having first face–to–face contact encouraged completers to reply and honest replies were given. A total of 63 out of 73 completers (86%) found being paid back ¥ 1 for their text message costs enough. This was also found good and practical. Some said that they did not have to send so many text messages and that sending text messages did not cost a lot. The incentive of ¥ 5 was found enough by 60 completers (82%) and this was the preferred incentive for 35 completers (48%). The most comments about incentives were related to the positive aspects of receiving ¥ 5 credit; some said that they did not expect the credit and that it was a nice surprise. Also, credit was found convenient, because it was not easy to buy the credit in the villages. However, some felt the amount was too much and that their effort was not enough for receiving ¥ 5. Negative comments included that it was felt that the survey may have other purposes when ¥ 5 was given. Only 16 completers (22%) preferred health information. Health information was valued, because it was important and needed. However, the received calendar with infant feeding information was from last year (2012) and hence less useful. Some completers said that the child liked the towel that we gave for the face–to–face interview, while others found it not worth much and did not want a small gift.

There were many comments related to perceived usefulness and ease of use and many of them were contradictory. Both methods were perceived to not take much time, but also to be time–consuming. For the text messaging method, it was

Table 4. Non–completers' positive and negative views on face–to–face and text messaging survey

Factors	Face–to–face survey		Text messaging survey		
	Positive	Negative	Positive	Negative	Other
Mobile phone usage				Not used to mobile phone Not used to send text messages a lot Used to making phone calls	
Ability to use mobile phone				Mobile phone is not easy to use	
Problems with mobile phone				Mobile phone does not function well Do not have credit	
Checking mobile phone			Take the mobile phone with me	Did not check mobile phone	
Available time		Do not have time for interview		Do not have time; busy, take care of the child Cannot reply timely	
Paying back text message costs			The amount of money is OK Good to be paid back		Do not mind about money It is OK even without; it is for the child, it is honest Does not matter; do not have time If there were more questions, it is not enough The more the better
Study incentive (see **Table 5**)					
Trust		Asked sensitive questions face–to–face		It is hard to trust text messages	Only want to reply to questions about the child
Perceived usefulness of process	Useful because can get information from interviewers			Not useful; cannot get information It is too late, afraid the survey ended, think it is not useful to reply	
		Time–consuming to participate Cannot participate in own time	Faster to reply Can reply in own time Can reply when nothing else to do	Time–consuming to reply Slow to reply	
Perceived usefulness of outcome			Aim of survey is OK, or good It is for the child's sake	Do not know the aim of survey Not useful; child is not ill Only asked question, did not tell how to prevent diseases	
Perceived ease of use		Too much effort to participate, have to go out Not easy to conduct for researchers	Not too much effort Do not have difficulties, easy to reply	Too much effort to reply Hard to reply Very likely to make a mistake with a mobile phone	
	Convenient to participate		Convenient to reply	Inconvenient to reply Sending time was not appropriate, was sleeping Will not reply if forget Text messaging scares the child	
	Questions are clear Detailed questions		Questions are clear Detailed questions	Questions are not clear	Questions were the same
Attitude				Too many text messages	Not so many questions for text messaging, many questions in face–to–face survey No preference, methods are equally OK Methods are almost the same
Actual use			Did reply to text message		

Table 5. Non–completers' positive and negative views on study incentives

Towel (worth ¥ 5)		¥ 5 mobile phone credit		Health information		
Positive	Negative	Positive	Negative	Positive	Negative	Other
Useful	Less useful	More useful	Small amount of credit, is useless	Useful	Will ask village doctor for health problem	Is OK if it is caring about the child, or beneficial
Practical	Can only use the towel once	More practical	Afraid to not receive credit	Cannot get health information		Do not lack these things
Use more towels with a child	Can buy towels	Inconvenient to buy credit in village	Can buy credit	Can use health information for a long time		All the same
	Did not like colour of towel	Use credit more		Health information text messages do not need reply		Will cooperate, no matter what the gift is
	Not worth a lot			On paper is convenient		Do not mind about gift
				You researchers know more than caregivers		
				Important		
				Need to know		

valued that a reply could be given at a self–chosen time and not having to be at a certain place. However, the text messaging survey was found less useful, because no questions could be asked. Both methods were found convenient, but it was inconvenient to reply to text messages, especially for grandparents. The aim of the text messaging survey was perceived as OK or good, because the child's health condition could be followed and we showed that we cared about the child. However, it was not perceived useful when the child did not have the disease symptoms we asked about. Both the face–to–face and text message were perceived as easy, but also too much effort. The text messages were found to be clear, detailed and understandable, but also unclear. For the face–to–face interview, feeling good was mentioned, but also feeling embarrassed. For the text message survey, completers said to feel at ease, but also to feel bothered.

The text message method was found to be good. Completers wanted to cooperate with our work and make a contribution to society. Most completers were willing to receive at least 3–4 or more text messages a day (63; 79%), and more than eight text message questions in total (61; 84%). However, it was also mentioned to get annoyed when receiving too many text messages. A total of 51 participants (70%) said to be willing to complete a text message survey at least once a month. Frequently mentioned was that all methods were OK and to not have a preference. However, when completers had to choose, 35 (48%) preferred the face–to–face and 35 (48%) the text message method.

Researchers. We found four additional factors influencing follow–up: (i) different caregivers participating in face–to–face and text message survey, (ii) sending text messages manually, (iii) caregivers' understanding of survey questions, and (iv) technical issues.

First, we found that 93 caregivers who came to the village clinics for the face–to–face survey were not the same person participating in the text messaging survey (**Table 9**): 8 participants in group 1 (of whom 6 replied the first survey text message question) and 85 participants in group 2 (of whom 76 replied to the first survey text message question and then participated in the face–to–face survey). This was mostly because mothers (46; 49%) replied to the text messages, but fathers (10), grandmothers (26), grandfathers (9) or another person (1) came to the face–to–face interview. Also frequently happened that the father responded to the text messages (40; 43%), but mothers (25), grandmothers (11) or grandfathers (4) came to the face–to–face interview. These caregivers had to be excluded from the analyses. In group 1, of the 189 participants who responded to the first survey text message question 183 caregivers (97%) were the same caregivers in the face–to–face and text message survey. In group 2, of the 302 participants who completed the face–to–face interview and responded to the first survey text message question, 226 (75%) were the same caregiver who participated in the text message and face–to–face survey.

Second, sending text messages manually was a labour intensive process. One researcher (YL) was continuously sending text messages 12 hours a day (from 9 AM till 9 PM) during the study period (14 days). Before and after sending text messages, she had to do additional work for the study (communicate with the fieldworkers and preparation and checking work). Sending text messages was relatively complicated, because we had to send text messages at different times to the two groups and we had to send participants questions depending on the response they gave. Therefore, we could not find a suitable Chinese automated text messaging system for this study. This manual work was prone to errors and a second person checked the text messages that were sent out. The researcher sent files containing ten messages to the second person who checked them. About one in five files contained one or two mistakes, which had to be revised. Even after these checks errors oc-

Table 6. Completers' experiences with and views on surveys (n = 73)

	No. (%)
Received text message reminder?	
Yes	26 (36)
No	41 (56)
Do not know	1 (1)
Missing (interviewee quit)	3 (4)
Missing (interviewer forgot to ask)	2 (3)
Acceptability text message reminder (n = 26)	
Received 1 reminder; is OK	15 (58)
Received 2 reminders; is OK	7 (27)
Received 2 reminders; is too much	1 (4)
Received 3 reminders; is OK	2 (7)
Missing (interviewer forgot to ask)	1 (4)
Time receiving text message acceptable?	
Yes	48 (66)
No	22 (30)
Do not know	1 (1)
Missing (interviewee quit)	2 (3)
Preferred time for text message survey	
Morning	4 (6)
Morning or afternoon	5 (7)
Morning or evening	2 (3)
Afternoon	16 (22)
Afternoon or evening	11 (14)
Evening	17 (23)
Any time	15 (21)
Do not know	1 (1)
Missing (interviewee quit)	2 (3)
Views on receiving ¥ 1 for text message costs	
Was enough	63 (86)
Was not enough	1 (1)
Did not mind	5 (7)
Missing (interviewee quit)	3 (5)
Missing (interviewer forgot to ask)	1 (1)
Views on receiving ¥ 5 mobile phone credit for completing text message survey	
Was enough	60 (82)
Was not enough	1 (1)
Was too much	2 (3)
Did not mind	6 (9)
Do not know	1 (1)
Missing (interviewee quit)	3 (4)
Preferred incentive	
¥ 5 mobile phone credit	35 (48)
Towel (worth ¥ 5)	6 (8)
Health information	16 (22)
No preference	13 (18)
Missing (interviewee quit)	3 (4)
Number of text message questions willing to answer on one day?	
1–2	4 (6)
3–4	14 (19)
5–6	23 (32)
7–8	1 (1)
>8	20 (27)
All OK	5 (7)
Missing (interviewee quit)	6 (8)
Number of text message questions willing to answer in total?	
3–4	1 (1)
5–6	3 (5)
7–8	1 (1)
>8	56 (77)
All OK	5 (7)
Missing (interviewee quit)	6 (8)
Missing (interviewer forgot to record)	1 (1)
How often willing to respond to text message survey?	
Once a month or more often	51 (70)
Once every 2 months	4 (6)
Once every 3 months	6 (8)
Once every 6 months	2 (3)
All OK	1 (1)
Do not know	3 (4)
Missing (interviewee quit)	6 (8)
Preferred survey method	
Face–to–face	35 (48)
Text messaging	35 (48)
Phone call	1 (1)
No preference	2 (3)

curred, which was confirmed by participants who said that they did not receive follow–up text messages and therefore could not complete the survey. We checked this and found that indeed we did not sent text messages to some participants. We assessed that about two percent of the messages were incorrectly sent (unpublished).

Third, despite carefully designing our text message survey [28], questions were not always understood or participants did not reply in our requested format. We found that about one in three text message responses were in an incorrect format and had to be checked. However, only a small proportion (about 4%) of participants had to be sent the text message again, which was mainly for questions about where care was sought (unpublished). This resulted in delayed follow–up of participants.

Fourthly, a positive factor for follow–up was that we did not experience technical issues such as network problems or issues with our text messaging system during the study.

Recommendations for improving follow–up. Table 10 presents non–responders', non–completers', and completers' recommendations for improving follow–up and our views. Non–completers provided more recommendations than non–responders and completers. A number of participants said to not know what could be changed to improve follow–up. This was just the situation in rural areas in China, by which was meant that now more parents had to go to work and grandparents then took care of the child. It would be better to do the research at a place where more parents took care of the child. There were no good solutions for changing the text message survey, because caregivers could not take the mobile phone with them all the time or would forget to bring it, some parents and many grandparents could not text message, and the text messaging method depends on the initiative of caregivers.

DISCUSSION

Principal results

Recruitment. Of the 4170 names of caregivers of children under five, we recruited only 1026 (25%) and included 1014 (24%) caregivers. Based on interviews with village doctors and our experiences, we found several factors explaining this finding and recommendations for ways to recruit more caregivers.

Factors influencing recruitment. We found the following factors influencing recruitment: reachability of villages, fieldwork schedule, availability of village doctors, efforts of village doctors, availability of name list, availability of phone numbers, time of recruitment, selection criteria for recruiting caregivers, using the villages' loudspeaker, making phone calls, visiting caregivers' houses, and other re-

Table 7. Completers' positive and negative views on face–to–face and text messaging survey

Factors	Face–to–face survey		Text messaging survey		
	Positive	Negative	Positive	Negative	Other
Mobile phone usage				Do not use text messaging very often	
Ability to use mobile phone				Not easy to communicate via text messaging	
Problems with mobile phone			Have enough credit		
Checking mobile phone				Sometimes will not reply immediately, because do not see text message	
				Afraid that I cannot receive the text messages	
				I am unsure whether I can see the text message	
Available time	Have time for interview	Do not have time for interview	Will reply in spare time	Normally do not have time	
				Do not have time to send text messages	
Paying back text message costs			Ok or good to be paid back		Do not know
			Practical		Do not mind
			Do not mind about that, but better to be paid back		
			Did not need to send many text messages, does not cost a lot, not enough when there are more text messages		
			Good that parents do not have to pay		
			Depends on the aim, it is for the child, so does not matter		
			Do not have to pay for it		
Study incentive (see **Table 8**)					
Trust			Replied because you first contacted me face–to–face	Text messages are hard to trust	
			Gave honest replies	There are a lot of cheating text messages	
				Cannot reply as you required, afraid that replying in format results in higher costs	
				Do not reply to a strange number	
Perceived usefulness of process	Not time– consuming	Time–consuming	Faster than face–to–face interview	Takes a long time to reply	
	Can ask questions directly			Inconvenient for me to ask questions	You can easily ask questions in phone calls
			Saves time		Phone calls save time
			Saves time, can continue work	Cannot reply at work	Phone calls take a long time
			Can reply in own time when not busy		
	Convenient		Convenient to reply	Inconvenient to reply	Phone calls are convenient
		Have to be at the clinic at a set time	Do not have to be at a particular place	Inconvenient for grandparents to reply	
			Do not need to go out	Inconvenient to reply when taking care of child	
			No time limit for replying to text messages		
	More detailed		Questions are detailed	Text messages are not detailed	

Table 7. continued

Factors	Face–to–face survey		Text messaging survey		
	Positive	Negative	Positive	Negative	Other
			You can get specific information; you asked a lot of questions	It is too simple, you only asked a few questions	
Perceived usefulness of outcome			Aim of survey is OK, good, or very good	Aim of your work is not so useful	You asked the same questions face–to–face and via text messaging
			You care about the child		
			You can follow the child's health condition	Child does not have symptoms you asked	Worth replying if I can ask questions
			You can understand my child's health condition immediately		
			It makes me conscious about my child's health condition		
Perceived ease of use	Easy	Too much effort	Simple	Too much effort	
				Will not always reply	
				It is easy to forget to reply	
			Good to have a long interval between text messages	Text message software is slow, too long interval between text messages	You can explain things in phone calls
			Do not need to talk		
				When having questions, will not ask	
	Clear		Text messages are clear	Text messages are not clear	Phone calls are clear
			Can understand the text messages	Not easy to understand the text messages	
			Content of text messages is good/ questions are good	Did not understand the question	
	Feel good because it is intimate	Feel embarrassed	Feel at ease	Bothering	
			Easy to recall	Some of the text messages were repeated	
			Have time to think about it	There are things that you cannot say in text messages (complicated things)	
			Better to read than listen	Will be distracted when sending text messages	
Attitude			Text messaging method is good	Text messaging is less good than making phone calls	All methods are OK
			Way to do it is good	Text messages were too frequent	Like both methods
			Want to cooperate with your work	Get annoyed when receiving many text messages	Both methods have their own benefits
			Want to make contribution to society		Methods are (almost) the same, no preference
			Willing to participate		

cruitment methods. Furthermore, village doctors' work–related factors were their duties, division of their work, work load, gathering caregivers for vaccination, and experience with recruiting caregivers for previous studies. Village doctors' motivations were their understanding of the study, interference with work, money, work for villagers, follow orders from township and county hospital doctors, and cooperate with research team. Factors related to caregivers' characteristics were their education and ability to text message. Caregivers' motivations included understanding of the study, interference with work, trust, sensitive questions, reward (towel), and health information.

Recommendations for ways to recruit more caregivers. Feasible ways to recruit more caregivers were giving the name list and phone numbers in advance, visit villages earlier on the day, continue using the villages' loudspeakers, continue making phone calls and send text messages, give village doctors more time for visiting caregivers' homes, and bring a doctor for free consultation and send health information text messages. Moreover, to address factors that negatively influenced recruitment, we suggest developing and testing new information materials for village doctors and caregivers, omitting sensitive questions from survey, and tailoring recruitment strategies to the specific context of villages.

Table 8. Completers' positive and negative views on study incentives

Towel (worth ¥ 5)		¥ 5 mobile phone credit			Health information		
Positive	Negative	Positive	Negative	Other	Positive	Negative	Other
		It is OK, or good		It depends, it is hard to say	Need health information		All of them are OK
		Nice gift, shows that you are kind	Makes me feel that it has other bad purposes	Does not matter, will reply anyway	Hope to know more about child health		
Child likes gift		Nice surprise		It is for the child	Child health is important		It is OK to get it or not, if it is for the child
							Want the child to be happy
Useful		Useful					
		Convenient					
	Easy to get gift, not precious	Good you recharge credit, it is inconvenient to recharge					
Benefit	Worried about quality of gift	Benefit				2012 calendar is not good*	
	Is not worth much	It is a lot, not necessary	Reward is not a lot	Small amount of money, do not mind			
	Do not want a small gift	Would like to reply when getting ¥ 5	It only paid back the credit I used	The more the better			
		It is an incentive, makes it more likely that I reply					
		Good that parents do not have to pay for text messages		If there are many participants, it is a lot of money			
		Good to be paid, because it takes some of my work time to reply					
		Money for the time I spent					
		Feel that I did not do so many things					

*We gave a calendar with infant feeding information, which we developed in a previous study in 2012.

Table 9. Number of different caregivers participating in face–to–face and text messaging survey (n = 93)

Face–to–face	Text messaging				
	Mother	Father	Grand-mother	Grand-father	Other caregiver
Mother	0	25	2	1	3
Father	10	0	0	0	1
Grandmother	26	11	0	0	0
Grandfather	9	4	0	0	0
Other caregiver	1	0	0	0	0
Total	46	40	2	1	4

Follow–up. Of the 1014 participants included in the cross–over study, 662 (65%) responded to the first question about willingness to participate, 538 (53%) responded to the first survey question, and 356 (35%) completed the text message survey. Of the 349 participants in group 2 who were required to return to the village clinic for the face–to–face interview, 302 (87%) attended. Based on the interviews with participants and our experiences, we found several factors explaining these findings and recommendations to improve follow–up.

Factors influencing follow–up. In interviews with non–responders, non–completers and completers, there were mainly negative views on factors influencing follow–up related to mobile phone use, ability to use the mobile phone, problems with the mobile phone, checking the mobile phone, available time, trust and culture. Participants' limited mobile phone use or inability to use the mobile phone to text message restricted them in replying to text messages. Non–responders seemed to have more problems with their mobile phone and with checking their mobile phone than non–completers and completers. Participants mentioned not having time for both the face–to–face and text message surveys. Non–completers and completers perceived paying back text message costs as a positive factor and had varying views on the incentives. Non–completers seemed to have been keener to participate when health information was provided, while completers seemed happy

Table 10. Participants' and our recommendations for improving follow–up

	Participants' recommendations	Our recommendations
Non–responders	Explain purpose more clearly	Develop and test new information materials
	Should pay attention to hand, foot, mouth disease*	Explore sending participants health information of their interest
	Using a normal mobile phone number to send text messages	Technically not feasible; instead informing participants about the phone number
	Should mention "Capital Institute of Pediatrics" in text message	Feasible
	Send text message at an appropriate time	Explore giving participants the option of choosing a time of their convenience at which text messages are sent
	It is convenient to make phone calls	Not feasible, too time–consuming and costly
	Do not know/ Do not have comments	–
Non–completers	Explain the aim more clearly	Develop and test new information materials
	Inform in different ways, village doctors, advertisement and so on	Explore different ways of informing caregivers
	Increase trust: use familiar number, sending a greeting, providing consultation	Explore these ways to increase trust
	Need to tell what to do with symptoms	Explore sending text messaging with health information of interest
	Send feedback	Explore sending text messages with feedback
	Pay for text messages immediately	Was technically not feasible; explore having a free text message number
	Send text messages at an appropriate time	Explore giving participants the option of choosing a time of their convenience at which text messages are sent
	Hope (the investigator) can send text messages quicker	Was technically not feasible; explore option
	Send all questions in one text message	Not feasible, does not fit in one text message and sending all text messages simultaneously was also not possible because questions depended on answers
	Should not be so many text message questions	
	Send more text message reminders	Explore giving participants the option of choosing how many reminders are sent
	Send fewer text message reminders	
	Using text messaging for follow–up study	Good strategy
	Ask questions by making phone calls	Not feasible, too time–consuming and costly
	Not so much needs to be changed	–
	Do not know	–
Completers	Focus on more common diseases	Explore sending text messaging with health information of interest
	Hope you can give consultation about child's health	Explore sending text messages with feedback
	Need feedback for the text messages sent	
	Do not have comments	–

*Infectious child disease, usually caused by Coxsackie virus. Symptoms are blisters on hands, feet and mouth, and fever.

with the ¥ 5 reward for completing the survey (which non–completers did not receive). Non–responders only had negative views on perceived usefulness of the process, while non–completers and completers also had positive views. All different participants had both positive and negative views on perceived usefulness of the outcome and perceived ease of use.

We found four additional factors influencing follow–up: different caregivers participating in face–to–face and text message survey, sending text messages manually, caregivers' understanding of survey questions, and technical issues. We found that mainly when mothers responded to the text message survey, grandmothers participated in the face–to–face survey, or that fathers responded to the text message survey and mothers participated in the face–to–face survey. Sending text messages manually was time–consuming and introduced errors. Also, despite carefully designing the text message survey, errors occurred when caregivers did not understand the questions. Positive was that we did not experience technical problems during the study.

Recommendations for improving follow–up. Recommendations to improve follow–up were various. Based on participants' recommendations, we suggested a number of strategies to improve follow–up including the following: developing and testing new information materials, sending health information and feedback text messages, explore ways to increase trust and tailoring the text message survey to participants' preferences.

Strengths and limitations

To our knowledge, this is the first study exploring factors influencing recruitment and follow–up in an mHealth study in a middle–income country. The study took place in rural Northern China and our pragmatic approach pro-

vided information about a real–life setting. We have been conducting studies for a number of years in our field site and we had good relations with the local health workers. Therefore, we were aware of the local customs and could communicate in the local dialect (which is slightly different from standard Chinese) [28].

We provided an overall perspective by evaluating views from both village doctors and participants of the cross–over study, and by adding our own views. To ensure that the interpretation of the meaning of the data was correct, we collected and analysed the data in Chinese, translated the main findings into English, translated the English main findings back into Chinese, compared this with the original data and resolved disagreements. In addition, we had several discussions in our research team to confirm validity of findings. However, with any translation some meaning of the original language will be lost.

Our study was exploratory and only provided insights in factors that influenced recruitment and follow–up. We could not assess the effects of strategies used to improve recruitment and follow–up. Also, we could not collect detailed information on non–consenters and thus we could not assess the amount of selection bias.

The interviews covered a broad range of issues and we did not reach saturation on specific issues. Participants provided critical and interesting insights in this underexplored research area. However, the findings need to be interpreted with caution, because we felt that participants sometimes gave socially desirable answers to our questions. We put these findings into perspective by adding our views. While the sample of village doctors was relatively small (N = 10), we interviewed village doctors from different villages, both male and female, aged between 29 and 63, and village doctors who had their own clinic and village doctors who shared a clinic. Despite our random selection, there were no grandmothers or grandfathers and in the sample of non–responders of the cross–over study. Therefore, views of those participants mainly represent parents' views.

Telephone interviews have their own benefits and shortcomings [43,44]. We were able to interview a relatively large number of participants in a short amount of time without having to revisit all the villages, which practically would have been very difficult. Nevertheless, multiple methods of communication that are used in face–to–face interviews (body language and other visual cues) could not be used to interpret and communicate with the participants in telephone interviews. In addition, interviews were not audio taped and we relied on written responses of the interviewers.

Comparison with prior work

We conducted two mHealth data collection studies on infant feeding in our setting [45,46]. The first study (N = 258) took place a year before the cross–over study and aimed to evaluate the use of text messaging for program monitoring [45]. Based on our findings in this study, we checked the mobile phone number of caregivers ourselves (instead of asking village doctors to check them), we sent two reminders instead of one and we took into consideration the time at which most caregivers responded. In addition, we asked interviewers to remind caregivers to reply, to explain the format in which they had to reply and told them that they would receive ¥ 5 credit if they replied to all text messages. The second study (N = 591) is reported in this mHealth series and took place four months after the cross–over study [46]. The study explored the feasibility of text messaging data collection of infant and young child feeding practices. In that study, we sent all text message questions simultaneously to participants. We were unable to do this in the cross–over study, because the questions that we sent depended on the answer participants gave.

Representativeness of mHealth study samples is an important issue for selection bias. In our setting, the illiteracy rate was low and we did not find problems with illiteracy in current and previous research [45,46]. Mobile phone use was high and most parents could text message, but many grandparents could not text message and thus had to be excluded from participation. However, this may not be problem in settings where elderly people are able to text message [47]. Previous mHealth data collection studies frequently only included younger participants [10–13,15,20,21]. While in other settings socio–economic factors may influence use of mobile phones and text messaging [9], this did not seem to be of large influence in our setting as the costs of text messaging were very low (receiving text messages is free and sending one text message costs ¥ 0.1, about £ 0.01, € 0.01, US$ 0.02).

When participants are recruited in mHealth studies, it is important to know whether participants who are followed up are different to those who are lost to follow–up. In our second mHealth study, we did not find significant differences in demographic characteristics between responders and non–responders of the text message survey [46], and a similar finding was reported by an mHealth data collection study in Sweden [19]. Retention bias is influenced by a number of factors. Text messaging is more likely to work when there is follow–up, the text message is personally tailored and the content and frequency are highly relevant [1]. Researchers have successfully followed participants up in mHealth data collection studies by having face–to–face contact, sending text message reminders, making phone calls, and sending letters [11,15,19]. In our study, having face–to–face contact with caregivers seemed effective in increasing caregivers' trust, but we found that it remained hard to gain caregivers' trust. Not surprisingly, participants mentioned to not trust the text messages in the interviews. We made phone calls and sent

text messages to participants in group 2 to ask them to go to the village clinic for the face–to–face interview and achieved a high return of participants (87%). We sent two text message reminders and participants seemed to find this acceptable. Some participants perceived the text messages a reminder for their child health. A study in Kenya found that data collection text message served as medication reminders [10].

Some of the reasons for not responding to text messages we found have been previously reported. In our first mHealth study, we found similar reasons for not replying, including not receiving text messages, being too busy to reply, or not seeing the text message on time [45], but in the current paper we were able to give more in–depth explanations for reasons. As in our study, researchers in Thailand did not pay for the text messages and participants' ran out of credit. Also, participants mentioned running out of battery, technical challenges and not keeping mobile phones with them all the time [15]. A study in Uganda found that poor understanding and fear of making mistakes was an important challenge for completion of text message data forms [10]. We also found that some participants said it was likely to make mistakes via text messaging.

In our other mHealth studies, we used a smartphone to send the text messages [45,46], while we sent text messages manually with a text message system in this study. Manually sending text messages introduced errors, but this would not be completely resolved with an automated text message system. A study in the UK used an automated text messaging system, but out of 2952 text messages sent in total, still 214 (7%) text messages had to be sent manually [11]. As a result of system or researcher errors, about 6% of participants were sent the wrong number of text messages (too many or too few), while for about 2% of participants there were other problems [11].

The use of appropriate theory is often lacking in mHealth studies [1]. Although the Technology Acceptance Model was not specifically developed for the health care context, it has been used by a large number of studies for health care and is increasingly seen as fitting [48]. The model has mainly been used for predicting and explaining health workers' acceptance and use of health care information technology [49], but has also shown predictive value for consumers' adoption of health care information technology [50–52]. The model predicts a substantial portion of the use or acceptance of health care information technology, but may benefit from several additions and modifications. It has been recommended to further contextualize the Technology Acceptance Model to health care, which can uncover the specific meaning of generic variables [48]. A small number of mHealth studies have used the Technology Acceptance Model [49–51]. We found that the Technology Acceptance Model provided a useful framework for understanding follow–up of participants in our study.

Future research

There are a number of questions that remain and require further research. In our setting, the accuracy of the name list needs to be assessed by reporting how many children on the name list cannot be found in the villages. In addition, it needs to be reported how many caregivers are not able to participate and for what reasons. The suggested strategies to improve recruitment and follow–up need to be tested and their effectiveness needs to be assessed. The use of an automated text message system needs to be explored to reduce the work load of researchers and to further improve accuracy of sending the text messages. This would also allow us to send text messages quicker and at participants' preferred times. Future studies could use the Technology Acceptance Model to develop interview guides [53] and test the variables in the model for mHealth data collection [51].

CONCLUSIONS

This is the first study to explore factors influencing recruitment and follow–up of participants in an mHealth data collection study in a middle–income setting. The lessons learned in this study emphasize the importance of rigorously testing mHealth interventions in a new setting. More work is needed to implement our suggested strategies and assess their effectiveness. This work would be valuable as there is currently limited information available that can guide sample size calculations for mHealth–based studies. Knowing more about recruitment and retention of participants in mHealth studies would be an important step in improving mHealth evaluation. When mHealth interventions are sufficiently evaluated, successful mHealth interventions could be scaled–up and ultimately support the delivery of health care and improve health [1].

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mHealth Series: Measuring maternal newborn and child health coverage by text messaging – A county–level model for China

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Background Effective interventions in maternal, newborn and child health (MNCH), if achieving high level of population coverage, could prevent most of deaths in children under five years of age. High–quality measurements of MNCH coverage are essential for tracking progress and making evidence–based decisions.

Methods MNCH coverage data are mainly collected through field-workers' interview with preselected households in standard programs of Demographic and Health Surveys (DHS) or Multiple Indicator Cluster Surveys (MICS) in most low– and middle–income countries. Household surveys will continue to be the major data source for MNCH coverage in the foreseeable future. However, face–to–face data collection broadly used in household surveys is labor–intensive, time–consuming and expensive. Mobile phones are drawing more and more interest in medical research with the rapid increase in usage and text messaging could be an innovative way of data collection, that is, we could collect DHS data through mHealth method. We refer to it as "mDHS".

Finding We propose in this paper a conceptual model for measuring MNCH coverage by text messaging in China. In developing this model, we considered resource constraints, sample representativeness, sample size and survey bias. The components of the model are text messaging platform, routine health information system, health facilities, communities and households.

Conclusions Measuring MNCH interventions coverage by text messaging could be advantageous in many ways and establish a much larger evidence–base for MNCH health policies in China. Before mDHS could indeed be launched, research priorities would include a systematic assessment of routine health information systems and exploring feasibility to collect name lists, mobile phone numbers and general demographic and socio–economic data; qualitative interviews with health workers and caregivers; assessment of data validity of all indicators to be collected by text messaging; and exploring approaches to increase participation rate.

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Globally, in 2011 seven million children died before reaching their fifth birthday [1]. Effective interventions, if reaching all children in need, could prevent most of these deaths [2]. To maximize the effectiveness, interventions should be delivered under the principle of continuum of

care for mother and child, that is, from pregnancy, through birth, the newborn period, infancy and childhood. They should achieve the highest possible level of coverage [3]. Intervention coverage in maternal, newborn and child health (MNCH) is defined as the proportion of children under 5 years of age (or their caregivers, or pregnant women) in the population who needed the intervention and have actually received it [3]. Effective measurements of MNCH intervention coverage are very important to decision makers, program managers and donors for tracking the progress and making evidence–based decisions.

In most low– and middle– income countries, health management information systems are currently too weak to provide data of adequate quality for assessing and guiding health programs [4,5]. Therefore, data on MNCH coverage in these countries are mainly generated through household surveys in international standard programs of Demographic and Health Surveys (DHS) [6] or Multiple Indicator Cluster Surveys (MICS) [7]. Neither DHS nor MICS program is being implemented in China, and national surveys, such as National Health Services Survey and National Nutritional and Health Survey, are the major sources of MNCH coverage data [8,9]. An effective data collection method is essential for household surveys. Face–to–face interview with preselected households by trained field workers is broadly used around the world. This method, however, is labor–intensive, time consuming and expensive [10]. Nowadays, mobile technologies are increasingly drawing interest in medical research with the rapid increase of mobile phone use and text messaging could be an innovative way of data collection [11]. Text messaging does not require field visits. It is accessible for most people and offers an opportunity for real time data collection and no interviewer bias [10].

The recently published "Measuring Coverage in MNCH" Collection by *PLOS Medicine* [12] systematically assessed the validity of intervention coverage measurement based on household surveys. The studies showed that measurements of some indicators used to track intervention coverage may not be fully reliable [12]. In their strategies for improving coverage measurement through household surveys, "Incorporate information technology" was proposed and eHealth and mHealth were deemed as having important implications for coverage measurement and monitoring [12]. Technology can improve data quality in household surveys and is increasingly being used in real–time measurement of child health program indicators [13].

This article proposes a concept model of measuring MNCH coverage by text messaging at the county level in China. Using Zhào County, Hebei Province as a case study, we discuss why to measure MNCH coverage by text messaging, along with the challenges and future research agenda.

WHY MEASURE MNCH COVERAGE BY MOBILE TEXT MESSAGING

The *PLOS Medicine* Collection concluded that household surveys will continue to be the major data source for MNCH coverage in the foreseeable future [12]. However, DHS, MICS and other household surveys have significant problems that need to be addressed, such as, how to ensure that household surveys produce the best and most relevant information [12]. Some of these problems are inherently caused by the current data collection method of household surveys, that is, visiting households by trained fieldworkers to collect data using pen–and–paper or handheld electronic devices.

Resource constrains

Regular household surveys carried out according to minimum standards are required to provide frequent and high–quality coverage data for program monitoring [14]. However, in current household surveys (visiting households by fieldworkers to conduct face–to–face interview), recruitment, training, transportation and accommodation of interviewers and supervisors are very labor–intensive, time consuming and expensive, and hence a major constraint to frequent conduction of household surveys, especially in resource–limited settings. Using text messaging can achieve remote data collection and dramatically reduce personnel, time and cost. This could be invested either in increasing the coverage or used as an incentive for participants.

Sample representativeness

Most household surveys are sample surveys in which representative samples are preselected with each household having a known chance to be selected. Response rates are crucial because low response rates can damage the representativeness of the sample. However, high response rates are not easily achieved in the field since caregivers are often unavailable due to work outside home in day time or being too busy to be interviewed. Thanks to multiple revisits to households and close monitoring of response rates by field staff, non–response in DHS and MICS is well below 10% in most countries [15], but resource constrains need to be considered. In addition, poor transportation and security concerns prevent interviewers from visiting households in some circumstances. Experience indicated that interviewers have a tendency to modify children's age, such as transferring children to age group of over 5 years, to exclude them from the survey sample and thereby reduce interviewers' workload [15]. Moreover, some cultural or custom factors prevent fieldworkers to visit households. For example, in rural China, people believe that it is not good for newborns and mothers to be visited by other people within the first months of birth [16]. Therefore, fieldwork-

ers cannot go to households which often results in fewer newborns in an actual survey sample. Text messaging survey could overcome these problems as no household visits would be needed, potentially leading to increased representativeness of hard–to–reach populations, as all participants can respond at the time of their convenience.

Sample size

Sample size is another issue to be considered. An increased sample size is needed for disaggregated analysis by sex, age and socioeconomic status, and for indicators suffering from seasonality issues, such as prevalence of suspected pneumonia and diarrhea, because results from one survey in a year only represent a specific season and cannot provide a full picture of all seasons [17]. Very large samples are required for obtaining adequate denominators to support coverage measurement for low prevalence events [12]. Currently, DHS and MICS surveys include around 15 000 and 10 000 households respectively and are usually conducted every 5 years [15]. Due to limited resources, it is usually not feasible to conduct household surveys with very large samples or more frequently. Text messages could be sent to as many caregivers as possible to dramatically increase the sample size, and text messaging survey could be frequently conducted, eg, every 3 months or even more frequently, to catch the indicators in various seasons.

Survey bias

The current household surveys have some biases, such as interviewer bias and recall bias. Both DHS and MICS have minimum requirements for selecting interviewers, eg, having at least a high school diploma and not directly being involved in the management or provision of health services, to avoid potential conflict of interests [15]. In addition, all interviewers are trained on survey protocol and evaluated before conducting field work. However, interviewer bias cannot be completely avoided. In addition, most MNCH coverage indicators are gathered by recall of survey participants, with recall periods exceeding 2 years for some indicators. For example, a mother of 2–year–old child has to recall what happened two years ago when asked about initiation of breastfeeding of her child. A text messaging survey has no interviewer bias and could be conducted in real–time, thus significantly reducing the recall bias.

Mobile phone ownership increased rapidly worldwide, and China is no exception. In May 2013, there were almost as many mobile phone subscriptions as people in the world (estimated 6.8 billion mobile subscriptions) and 1.2 billion subscriptions in China, which equals to 85.9% of the population [18]. Zhào County has a total population of 580 000 and approximately 75% of the population has mobile phones. Nearly all households have at least one mobile phone [19]. Our literature review revealed that an increasing number of studies have explored the feasibility of using text messaging as a data collection method, and found that it was generally accepted by participants, had reasonable agreements and lower costs compared with other methods, and variable response rate [10,11,20–25]. Therefore, text messaging may possess a significant potential for overcoming constrains of face–to–face field interviews, and could be used as an alternative way of measuring MNCH coverage.

COMPONENTS OF THE MODEL

An appropriate text messaging platform is a prerequisite for measuring MNCH coverage by text messaging. Through sending and receiving messages, the platform builds relations with households. However, as an innovative data collection method, text messaging cannot operate on its own. Resources from routine health information system (HIS), health facilities and communities should be mobilized and utilized to maximize its effectiveness. Therefore, in our model, text messaging platform, routine HIS, health facilities, communities and households have their own roles and should be closely related to each other.

Information to be collected

In DHS, MICS and most other household surveys, in addition to coverage data, basic information on children and mothers, household information on demographic and social economic status are collected for further analysis, such as inequity analysis [4,6,14]. Maternal, Newborn and Child Health Household Survey (MNCH HHS) developed by the World Health Organization (WHO) also collects data on delivery channels of key interventions and reasons for coverage failures (unpublished data, 2009). All these need to be carefully considered for the feasibility of their collection by text messaging.

Roles of different partners

Roles of different partners are presented in **Figure 1**.

Text messaging platform. A text messaging platform consisting of software and management staff is the core of our model. The primary role of the text messaging platform would be to collect data from households by sending survey questions and receiving answers from which the MNCH coverage indicators are calculated. We could also send service reminders and health education messages to households. By explaining when, where, what and why of health services, service reminder messages have the potential to improve the recipients' recall of interventions they received. Health messages, such as breastfeeding and complementary feeding recommendations, may increase the survey response rate from households because caregivers could benefit from text messaging communications. In ad-

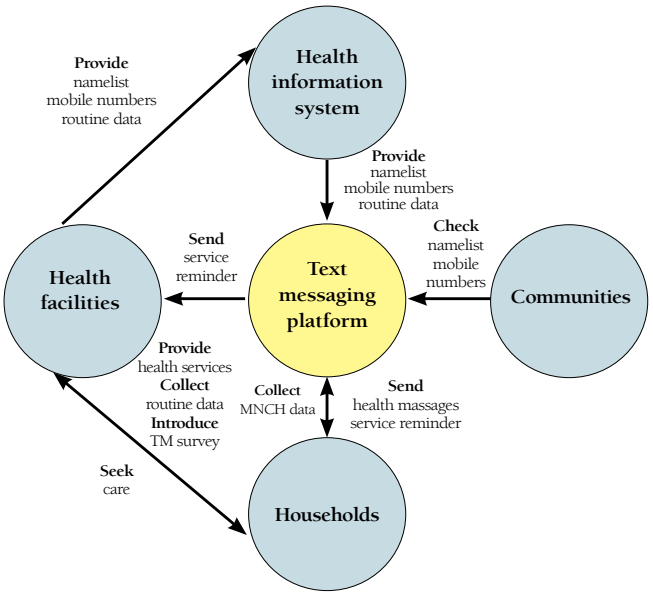

Figure 1. Roles and relationship of different partners in the model.

dition, text messages could also be sent to health workers to remind them of explaining services to health recipients. Therefore, service reminders and health messages hold a potential to improve the quality of MNCH coverage measurements.

Routine health information system. There are many sources of information from routine HIS, such as records of basic public health services for women and children, annual report system, monthly report of births from delivery institutions to the county Maternal and Child Health Hospital, etc. Some of these routine health records have been electronic as required by the basic public health programs, such as health archives, antenatal visits, postnatal visits, and child health care visits. Routine HIS is required to collect such information, therefore, could serve as a source of name lists and mobile numbers, both of which are the basis for text messaging data collection. All these electronic health records could be used to complement and cross–check each other.

Health facilities. County–level hospitals, township hospitals and village clinics are the main health facilities in Zhào County. They provide clinical and public health services for the population in their catchment areas. Health facilities can play an important role in measuring MNCH coverage.

First, health facilities are the main sources of routine HIS. The name lists, mobile phone numbers, basic information of children and their caregivers, and demographic and socio–economic information are mainly collected by health workers when providing health services in their facilities. The completeness, accuracy and timeliness of information from routine HIS highly depend on the performance of health workers and facilities. In addition, health facilities can help with the update of name lists and mobile phone numbers at every service contact with children and caregivers.

Second, good communication with service recipients may increase their willingness to respond and improve their recall of interventions. Response rate is a large challenge for a text messaging survey. Introduction of the survey to participants by health workers when providing health services may be an effective way to increase participants' responses. Recall bias of respondents is an important factor affecting the quality of coverage measurement by household surveys. Service recipients are more likely to forget interventions which they are not familiar with, or do not pay attention to. Therefore, careful explanations by health workers about contents and reasons of interventions being delivered are likely to improve recall [12].

Third, the extent and quality of health services provided by health facilities can help us better estimate coverage of some interventions [12]. For example, blood tests of syphilis, HIV and hepatitis B are the standard services for antenatal care in Zhào County MCH hospital. Pregnant women or mothers often did not know whether or not they had these tests, but they can remember whether or not they went to the county MCH hospital and gave blood samples. Therefore, we can link recipients' recall and hospital's standard services to estimate the coverage. Given the potential role to improve coverage measurement held by health facilities, government's efforts to strengthen health facilities should include quality of care as well as quality of health information.

Communities. Community workers, such as family planning workers, are familiar with households and births, and therefore could be used to check and validate the name lists and mobile phone numbers. They could also help with explanation of text messaging to caregivers.

Households. Households are the information source and crucial to the quality of data collected. They have direct contact with health facilities through care–seeking and with the text messaging platform through receiving and replying to text messages. Efforts are needed to familiarize households with text messaging survey.

Operation guidelines

Guidelines for operation of the programme are presented in **Figure 2**. Sample representativeness is essential for the accurate measurement of the MNCH coverage. To obtain a representative sample, a complete and accurate name list of target children needs to be acquired. Then, those name lists need to be checked and updated regularly, because children living in an area may migrate in and out or die. Mobile phone numbers of caregivers are prerequisite to text

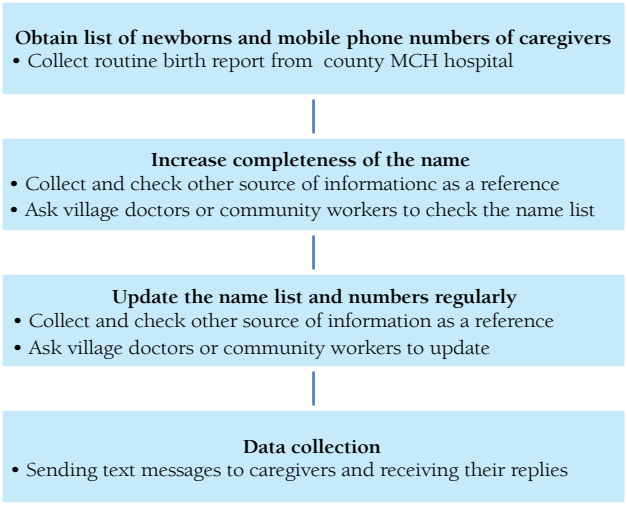

Figure 2. Procedure of text messaging data collection.

messaging data collection, and should be obtained at the same time as name lists. In addition, mobile phone numbers need to be validated and updated regularly. With the name lists and mobile phone numbers ready, data collection could begin.

Children can be delivered in township hospitals, county level hospital, hospitals outside the county or outside health facilities (eg, at home). All delivery facilities in Zhào County are required to report all deliveries to the county MCH hospital every month (Deliveries outside the county or outside health facilities may be missed). In Zhào County, 99.5% of newborns were delivered in hospitals (unpublished data), therefore, delivery institutions could be a good point for engagement of caregivers. They could be provided with information materials, explaining the purpose of the mHealth communications platform which will be used for data collection, and be educated on how to answer survey questions. Then we could collect routine information on birth from county MCH hospital every month to obtain name lists of newborns.

Since some births will be missed, other sources of information may be used to increase the completeness of the namelists. Possible routine HIS sources include antenatal visits of pregnant women from county level hospitals and township hospitals, annual report systems, and immunization records. In addition, routine HIS, village doctors and community workers can be used to update the namelists regularly.

Mobile phone numbers can be collected and updated by the same mechanism as name lists. However, mobile phone numbers collected are sometimes wrong due to mistakes of caregivers, health workers or data input, and therefore they have to be validated. To achieve this, text messages can be sent to all numbers and mobile phone holders can be asked to reply. Health workers and community workers can help with correction of wrong numbers

CHALLENGES

Although text messaging has a significant potential to be used to measure MNCH coverage in household surveys, there are many challenges which need to be addressed, including completeness and accuracy of children's name lists and caregivers' mobile phone numbers, data validity and response rate.

Completeness and accuracy of children's name lists and caregivers' mobile phone numbers

Households are the sample unit in DHS and MICS programs. In our model, children would be the sample unit and therefore, name lists of children have to be obtained through routine health information systems. The quality of routine health information systems is often low in low– and middle–income countries as well as in China [4,5], that is, the name lists are often incomplete and inaccurate. Mobile phone numbers would be the prerequisite to conduct text messaging surveys and would also be collected through routine health information systems. Data from different sources could be complemented and cross–checked with each other. However, the extent of the completeness and accuracy are still unknown.

Data validity

Data validity is an essential issue for any new method of collection to be accepted. Therefore, data collected by text messaging has to be validated before this new method is used to measure MNCH coverage. As indicated in recent studies, sensitivity and specificity of current coverage indicators measured by face–to–face interview are highly variable across interventions, with some indicators being very low [12]. This problem would also occur in a text messaging survey, or even worsen because caregivers may not understand the survey questions adequately due to limitations of length of messages, or lack of communication between interviewers and caregivers as in face–to–face survey. Moreover, answers to the survey questions are recorded by trained interviewers in face–to–face interviews, whereas in text messaging surveys, they would be entered by caregivers themselves, which may not be as standard as in face–to–face interviews.

Low response rate

Response rate is crucial to sample representativeness and sample size of household surveys. Non–response rate of household surveys in DHS and MICS could be controlled below 10%. However, it would be very difficult for a text

messaging survey to achieve such a high response rate. As indicated in literature, response rate of text messaging data collection varied from 6% to 100% [10,11,20–25]. Our studies in Zhào County showed low response rate of around 30% (our unpublished data). Increasing response rate of text messaging surveys is a big challenge in our model and multiple approaches need to be explored and tested in further studies.

FUTURE RESEARCH

Facing all challenges above, further research is needed to explore solutions to possible problems. Proposed research priorities are summarized below.

Systematic assessment of routine HIS and exploring feasibility to collect name lists, mobile phone numbers and general demographic and socio–economic data

The routine HIS in Zhào County include: 1) antenatal care visit to county MCH hospital; 2) antenatal care visit to township hospitals; 3) annual report system; 4) monthly birth report from delivery institutions to county MCH hospital; 5) contact with township hospitals for getting hospital delivery subsidies; 6) child health care visits to township hospitals; 7) namelists for immunization. We will systematically assess contents, mechanism and quality of these routine HIS and discuss the feasibility to collect namelists, mobile phone numbers, demographic and socio–economic data (see **Box 1** for information to be assessed).

Qualitative interviews with health workers and caregivers

Health workers and caregivers would be essential to text messaging surveys; therefore, it is important to understand their willingness to be involved and their attitude and possible preference towards using text messaging. Qualitative studies are therefore needed to explore their mobile phone use behaviour, and to obtain their opinions on text messaging surveys and possible problems and solutions.

Box 1 Data to be assessed in routine Health Information Systems

Who is responsible?
How are data collected?
Advantages and disadvantages of different data sources
Quality of data from different sources
What information is included?
Possibility to add or reduce information
Relations of different data sources
Possibility to integrate different data sources
Electronically or not?
Mobile phone numbers included?
Current mechanisms for dynamic update?
Any others?

Validating name lists and mobile phone numbers and exploring mechanisms of regular update of information

A household census should be conducted in some selected townships and villages to validate the name lists and mobile phone numbers collected by routine HIS. Using household census as gold standard, by comparison, could reveal to what extent data obtained from routine HIS are complete and accurate. Caregivers could also be interviewed during household census to explore the mechanism of regular update of the information.

Data validity

Coverage indicators to be measured in our model would cover antenatal care, delivery and postnatal care, infant and young child feeding practices and prevalence and care–seeking of pneumonia and diarrhea. Studies are needed to assess data validity of all indicators to be collected by text messaging. A standardized study protocol needs to be developed and tested, and the methodologies described in papers of *PLOS Medicine* Collection should be referred to.

Increase response rate

There are many factors which may affect the response rate of text messaging data collection, such as an advance letter, acquiring trust of participants, increasing attempts, targeting sending time, money incentives, providing health education messages, etc. [11,25–27]. Further studies need to be conducted to test the effectiveness of these approaches on increasing response rate of text messaging surveys.

Real measurement of MNCH coverage

A pilot real measurement of MNCH coverage is needed to test how to operate and problems encountered should be systematically recorded. Possible solutions to problems would also be explored and tested to further improve the model.

In this paper, we proposed a county–level conceptual model of using text messaging as a data collection tool to measure MNCH coverage in China. Text messaging may hold a great potential to be used in household survey. However, major challenges need to be addressed and further researches need to explore the feasibility of the model.

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mHealth Series: Text messaging data collection of infant and young child feeding practice in rural China – A feasibility study

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Background Face–to–face interviews by trained field workers are commonly used in household surveys. However, this data collection method is labor–intensive, time–consuming, expensive, prone to interviewer and recall bias and not easily scalable to increase sample representativeness.

Objective To explore the feasibility of using text messaging to collect information on infant and young child feeding practice in rural China.

Methods Our study was part of a clustered randomized controlled trial that recruited 591 mothers of children aged 12 to 29 months in rural China. We used the test–retest method: first we collected data through face–to–face interviews and then through text messages. We asked the same five questions on standard infant and young child feeding indicators for both methods and asked caregivers how they fed their children yesterday. We assessed the response rate of the text messaging method and compared data agreement of the two methods.

Finding In the text messaging survey, the response rate for the first question and the completion rate were 56.5% and 48.7%, respectively. Data agreement between the two methods was excellent for whether the baby was breastfed yesterday (question 1) (kappa, $\kappa = 0.81$), moderate for the times of drinking infant formula, fresh milk or yoghurt yesterday (question 2) (intraclass correlation coefficient, ICC = 0.46) and whether iron fortified food or iron supplement was consumed (question 3) ($\kappa = 0.44$), and poor for 24–hour dietary recall (question 4) (ICC = 0.13) and times of eating solid and semi–solid food yesterday (question 5) (ICC = 0.06). There was no significant difference in data agreement between the two surveys at different time intervals. For infant and young child feeding indicators from both surveys, continued breastfeeding at 1 year ($P = 1.000$), continued breastfeeding at 2 years ($P = 0.688$) and minimum meal frequency ($P = 0.056$) were not significantly different, whereas minimum dietary diversity, minimum accepted diet and consumption of iron–rich or iron fortified foods were significantly different ($P < 0.001$).

Conclusions The response rate for our text messaging survey was moderate compared to response rate of other studies using text messaging method and the data agreement between the two methods varied for different survey questions and infant and young child feeding indicators. Future research is needed to increase the response rate and improve data validity of text messaging data collection.

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Malnutrition of infants and young children is highly prevalent in low– and middle–income countries and closely linked, either directly or indirectly, to major causes of child deaths [1]. In 2012, 12.6% of Chinese children younger than five years were underweight and 9.4% were stunted [2]. Inadequate breastfeeding and complementary feeding are the major causes of undernutrition in young children [3]. Infant and young child feeding (IYCF) practice in China is suboptimal: the exclusive breastfeeding rate for infants younger than 6 months was only 27.6%; the proportion of infants aged 6–9 months who received complementary feeding was 43.3%; and the proportion of children aged 12–15 months who received continued breastfeeding was only 37.0% [4]. Therefore, there is an urgent need to improve IYCF practices in China. Accurate and timely measurements of IYCF indicators are essential to inform decision makers, program managers and donors to make evidence–based decisions.

Evidence–based maternal, newborn and child health (MNCH) interventions can improve the processes and outcomes of health care when appropriately implemented, and therefore contribute to reduction of the death for children under five [5]. The MNCH interventions should achieve high levels of coverage in children who need them to maximize the effectiveness [6]. High–quality measurements of intervention coverage are crucial to track progress and make evidence–based decisions [7]. MNCH coverage data in most low– and middle–income countries are mainly generated through household surveys, such as Demographic and Health Surveys (DHS) [7,8] and Multiple Indicator Cluster Surveys (MICS) [9]. In China, the nationally representative data on infant and young child feeding are mainly collected from the National Health Services Survey and National Nutritional and Health Survey. These two surveys are generally carried out every five years and face–to–face interviews with caregivers are the standard method for data collection [4,10].

However, face–to–face data collection is labor–intensive, time consuming and expensive [11]. Therefore, new methods need to be explored to overcome shortcomings of the face–to–face method and text messaging could be an innovative way of data collection due to the rapid increase in mobile phone use [12]. In 2013, there were almost as many mobile phone subscriptions as people in the world, with more than half in the Asia–Pacific region (3.5 billion out of 6.8 billion total subscriptions) [13]. In China, there were more than 1.1 billion mobile phone subscriptions as of May 2013 [14] and text messaging is very commonly used. Text messaging could be used to measure MNCH coverage in China [15]. Text messaging has a significant potential to reduce the cost, and interviewer and recall bias and to increase the sample size and sample representativeness of household surveys [15]. However, there are also many challenges for text messaging data collection and a series of studies need to be conducted before this method could be used [15]. Data validity and response rate are the two major issues that need to be addressed. The MNCH coverage indicators that could be collected by text messaging method include antenatal care, delivery and postnatal care, infant and young child feeding, immunization and common childhood diseases [16]. This study will explore the feasibility of using text messaging to collect data on IYCF practices.

METHODS

We used test–retest method to compare two data collection methods for 24–hour recall of infant and young child feeding: face–to–face vs text messaging. The current feasibility study was part of a larger study, a clustered randomized controlled trial, aiming to evaluate the effectiveness of QQ (a popular Chinese instant messaging program) as a channel to deliver IYCF information, in reducing anemia prevalence in Zhao County, Hebei Province, China. For the trial, we collected data on IYCF practices using face–to–face method in the end line survey of the trial. To conduct the current feasibility study, we collected the same data again from the same participants by text messaging method (QQ was only used in the trial for delivering IYCF information to mothers of children, not for data collection in this feasibility study). On one day, we first conducted face–to–face interviews with mothers during the day, and then asked them to reply to our text messages that had the same questions in the evening after 18:00.

Study setting

We carried out this study in seven townships, Zhao County, Hebei Province, China (detailed description of the study setting can be found elsewhere [17,18].

Participants

Prior to this study, we conducted a baseline survey for the clustered randomized controlled trial (cRCT) in January 2013 and recruited caregivers of all children aged 6–23 months in the seven townships. Caregivers were eligible for this comparison study if they: 1) took part in the baseline survey of the trial; 2) were mothers of the child (our previous experiences indicated that grandparents were generally unable to reply text messages and fathers usually did not know the child's feeding behavior); 3) had mobile phones and were able to reply to text messages; 4) were willing to participate. We excluded mothers who completed face to face survey after 18:00, because our text messaging survey started at 18:00.

Training of interviewers

Interviewers for the face to face survey were medical students from Hebei Medical University and were trained for two days on the survey procedures. The training consisted

of communication skills, explanation of questionnaires, demonstration, role plays, field practice, and group discussion throughout the course. Interviewers were encouraged to ask questions when they encountered any problems. Inter– and intra–interviewer reliability for completing survey instruments after the training was assessed using a standardized role play by two supervisors. The reliability was over 95% in all measurements.

Recruitment

A doctor from Zhao County Maternal and Child Health Hospital was our local guide, and helped us to connect with local township doctors and village doctors. We obtained the name list of both children and their mothers with mobile phone numbers of mothers from the baseline study. Using the name list, the county doctor contacted township doctors before the study started to arrange an appropriate time for the interviews. The township doctors then informed village doctors of the accurate time for interviewing and asked them to recruit mothers on the name list to come to the village clinics. When mothers came to clinics, the supervisors first checked their phone numbers. If mothers had changed their numbers, supervisors recorded the new numbers and then informed a team member (XD) who sent text messages in Beijing to update numbers. The interviewers obtained written informed consent for both face to face and text messaging surveys. After the face–to–face survey, the interviewers reminded mothers to reply to the text messages before 12:00 AM at night, and explain in which format they had to reply to the text messages. We gave each mother a towel of 5 Yuan (¥) (equal to US$ 0.81) for her time in the face–to–face study and we paid ¥ 5 mobile phone credit to mothers who completed text messaging survey.

Questionnaires and pilot study

This study included two survey questionnaires: (i) the traditional face to face survey and (ii) the text messaging survey.

For the face–to–face survey, we used the WHO questionnaires for assessing IYCF practices, which had been adapted to local context in Zhao County and been used in our previous studies [16,17].

For the text messaging survey, our study team first discussed how to adapt the seven questions that were used in face–to–face survey, so that they had similar content, but more understandable in text messaging format and easier to reply to. All seven questions were then tested in a pilot study. We selected a convenience sample of 217 caregivers in Shahedian Township (not included in the feasibility study), Zhao County, and after obtaining informed consent, we sent seven text messaging questions to them. For the pilot study, 105 (48.4%) out of 217 participants responded to our first question and 26 (12.0%) out of 217 completed all seven questions. After the pilot, we conducted interviews with mothers in Shahedian Township to collect their feedback and advices on our text messaging questions.

For each question, we asked mothers what the questions meant and whether there were any problems in understanding our text messaging questions. We also encouraged them to offer their advice to make the questions easier to understand.

We planned to interview mothers who replied in the pilot study and those who never received our text messaging questions, because mothers who replied may have been more familiar with our text messaging questions and may have encountered problems when responding. This way we could obtain more insight in how to revise our text messaging questions based on their previous experiences. For those who did not receive message questions, we sent each text messaging question via an iPhone 4 and asked them to reply to us during the interview. We checked their reply messages immediately and if we found that there were any unclear answerers, we asked the mothers why they replied like this and whether there was anything else that was unclear in the text message.

We interviewed 18 mothers in Shahedian Township: nine of them had replied to all text messages and nine had not received our text messages (not included in the feasibility study). We revised our text messaging questions according to mothers' feedback, and the main changes were: 1) reduced the total number of text messages (from 7 to 5); 2) changed the order of text messages; 3) adapted the content of text messages (see Online Supplementary Document). The final text messaging survey consisted of nine messages: three introduction messages (Text Message 1–3) which did not need a reply, five survey question messages (Text Message 4–8) from which six IYCF indicators can be calculated, and one "Thank you" message. Detailed description of the text messages is shown in **Box 1**.

Data collection and entry process

Face–to–face survey. Village doctors asked eligible mothers to gather in village clinics for the interviews. Interviewers recorded mothers' responses with a smart phone. The smart phones automatically recorded the time of completed questionnaires and uploaded the data into an excel database. The advantages of using smart phone for data collection can be found in our former study [17].

Text messaging survey. We sent text messages to mothers who took part in the face–to–face survey. A team member first sent three introduction text messages to mothers in order to introduce ourselves, tell mothers how to correctly reply to text messages and inform them of the ¥ 5 (equal to US$ 0.81) mobile phone credit for completing this survey. Then we sent five text messaging questions simultane-

Box 1 Text messaging survey contents

Text message1

Hello! This is Zhao County Maternal and Child Health Hospital and Capital Institute of Pediatrics. We have tested hemoglobin in your child earlier today. Now we would like to ask you some questions about feeding of your child through text messages.

Text message 2

We will send 5 text message questions simultaneously to you at 18:00, please reply to each text message separately. See next message for reply formats. If you answer all 5 questions, you will receive 5 Yuan mobile phone credit within 2 weeks.

Text message 3

Please respond with the following format: question number + your answer.

Text message 4 (Q1)

Was your child breastfed yesterday during the day or at night(from 6:00 am yesterday to 6:00 am today)?Please respond: the number of this question + your answer to this question.

Text message 5 (Q2)

How many times did your child drink infant formula, fresh milk, or yoghurt yesterday during the day or at night (from 6:00 am yesterday to 6:00 am today) totally? Please respond: the number of this question + your answer to this question.

Text message 6 (Q3)

Yesterday, during the day or night (from 6:00 am yesterday to 6:00 am today), did your child consume iron fortified infant formula, iron fortified rice, iron fortified noodles, or any iron supplement (including liquids, powders or sprinkles)? Please respond: the number of this question + which one did your child consume.

Text message 7 (Q4)

Please recall the order of time and list everything (including meals and snacks) that your child ate or drank from 6:00 am yesterday to 6:00 am today, whether at home or outside the home. Please respond: the number of this question + your answer to this question.

Text message 8 (Q5)

From 6:00 am yesterday to 6:00 am today, how many times did your child eat solid, semisolid, or soft foods other than liquids? All thick foods should be included, eg, noodles, steamed bread, cookies, bread, meat, fruits, vegetables, eggs and thick porridge, etc. Only one or two bites of foods, and liquids (water, thin soup and drinks) should not be included. Please respond: the number of this question + your answer to this question.

Text message 9

This is the end of the survey. Thank you very much for your participation! You will receive ¥ 5 mobile credit within two weeks.

ously at 18:00. We numbered all five questions and asked mothers to add in their reply messages the same number of each question. A text message was sent as a reminder at 19:00 and 20:00 if mothers had not replied to all text messages. Finally we sent a "thank you" message to those who completed text messaging survey and told them they would receive ¥ 5 (equal to US$ 0.81) mobile credit for their fees of replying text messages and time consumption.

We used a Chinese text messaging system (Shangjibao,商机宝) for sending and receiving text messages. We asked customer–service workers of the system to contact us if there was any problem with sending and receiving messages.

Two of the team member (XD,XR) transferred answers of text messaging responding to numbers independently in order to create text messaging database, disagreements were solved by consulting a third team member who was experienced with nutritional surveys (QW).

Outcomes. The primary outcomes of our study were the response rate of text messaging survey and data agreement between the two methods. The secondary outcome was the difference in IYCF indicators between the responders and non–responders of text messages.

Response rate. In the text messaging survey, we defined and reported the response rate in two ways: (i) response rate to the first question; proportion of mothers who responded to the first question, and (ii) completion rate; proportion of mothers who responded to all five questions.

Data agreement. We compared the answers to each question from the face–to–face survey and text messaging survey by the same individual mother. For test–retest method, ideally there should be an appropriate time interval between the two tests, but there were no early literature for reference in our study. We compared data agreement of the two surveys at different time intervals. We first divided mothers who replied to our text messages into two groups by a specific time point: before 11:45 group and after 11:45 group because at this time point the number of mothers in each group was similar. We then calculated time interval between the two methods using text messaging sending time (18:00) subtracting the completion time of the face–to–face survey. In addition, we also compared the IYCF indicators calculated from face–to–face survey and text messaging survey between the two groups. More detailed information on the calculation of selected IYCF indicators can be found in Online Supplementary Document.

Difference in IYCF indicators between the responders and non–responders to the text messages

We calculated and compared IYCF indicators of responders and non–responders of text messaging based on the face–to–face survey.

Data analysis. We used chi–square test and Mann-Whitney U/Wilcoxon W (MWU/WW) test to compare the characteristics of responders and non–responders of text messaging survey. In addition, we assessed data agreement by kappa (κ) values (simple κ for categorical variable), intraclass correlation coefficient (ICC, for quantitative variables) and percentages of the same answers in both methods. We used McNemar's test for binary outcomes and extended McNemar's test [19] for nominal variables to detect differences between survey methods in IYCF indicators. We used SAS 9.1 (SAS Institute, Cary, NC, USA) for the analysis and we considered a P–value less than 0.05 as statistically significant.

RESULTS

Among 788 caregivers who participated in the end line survey of the clustered randomized controlled trial, 591 mothers were eligible for our text messaging survey. A total of 197 caregivers were excluded because they were not mothers (n = 97), completed the face–to–face survey after 18:00 (n = 13), had no mobile phones (n = 52), had twins (n = 6), or we failed to send text messages (n = 29) (field supervisors forgot to inform the text message sender). **Table 1** lists the demographic characteristics of mothers and their children. The demographic characteristics between the responders and non–responders were similar.

Response rate

Figure 1 shows the response rate of each question for the text messaging survey. The response rate of the first question was 56.5% and the completion rate was 48.7% respectively. There was a slightly decreased trend ($P = 0.022$) in response rates.

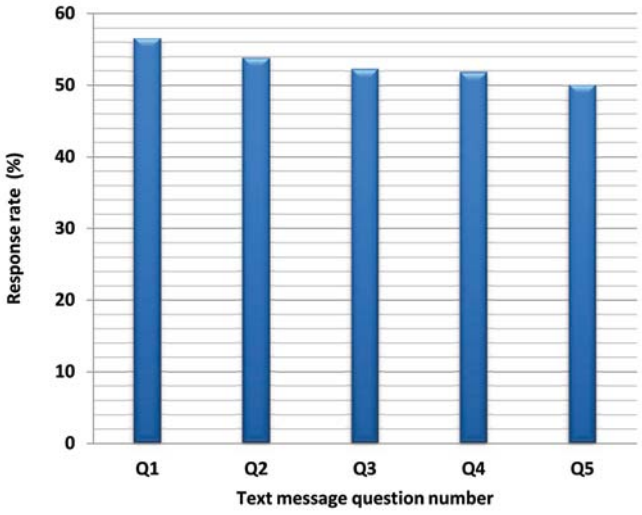

Figure 1. Response rate of each question for text messaging survey.

Figure 2 indicates the percentage of mothers who replied different numbers of text messages. There were 253 (42.8%) out of 591 mothers who never responded and 288 (48.7%) out of 591 mothers who completed our text messaging survey. Very few mothers 50 (8.5%) out of 591 who responded did not complete the text message survey.

Data agreement

Table 2 shows that agreement between the two methods for all five questions varied to a great extent. Agreement was excellent for the first question (κ = 0.81, 95% confidence interval 0.75–0.86), moderate for the second (ICC = 0.46, 95% confidence interval 0.37–0.55) and third questions (κ = 0.44 95% confidence interval 0.30–0.58), and poor for

Table 1. Demographic characteristics of children and their mothers

Variable	Total (No., %)	Responders of text messages* (No., %)	Nonresponders of text messages* (No., %)	Statistics	P value
Children					
Gender:					
Boy	302 (51.1)	145 (50.4)	157 (51.8)	$\chi^2 = 0.13$	0.721
Girl	289 (48.9)	143 (49.6)	146 (48.2)		
Age in months:					
12–23	451 (76.3)	215 (74.7)	236 (77.9)	$\chi^2 = 0.86$	0.355
24–29	140 (23.7)	73 (25.3)	67 (22.1)		
Mothers					
Median age in years (Q1–Q3)	25 (24–28)	25 (24–28)	25 (23–29)	MWU/WW Z = –0. 83	0.410
Years of education:					
0–9	488(82.6)	237 (82.3)	251 (82.8)	Fisher exact test	0.933
10–18	100(16.9)	50 (17.4)	50 (16.5)		
Unknown	3(0.5)	1 (0.3)	2 (0.7)		
Occupation:					
Home	541 (91.5)	263 (91.3)	278 (91.8)	$\chi^2 = 0.04$	0.851
Work	50 (8.5)	25 (8.7)	25 (8.2)		
Mother is the primary caregiver:					
Yes	492 (83.3)	246 (85.4)	246 (81.2)	$\chi^2 = 1.89$	0.169
No	99 (16.8)	42 (14.6)	57 (18.8)		

MWU/WW – Mann-Whitney U/Wilcoxon test

*We defined responders as mothers who replied to all five text messages, and non–responders as mothers who did not reply to all five text messages.

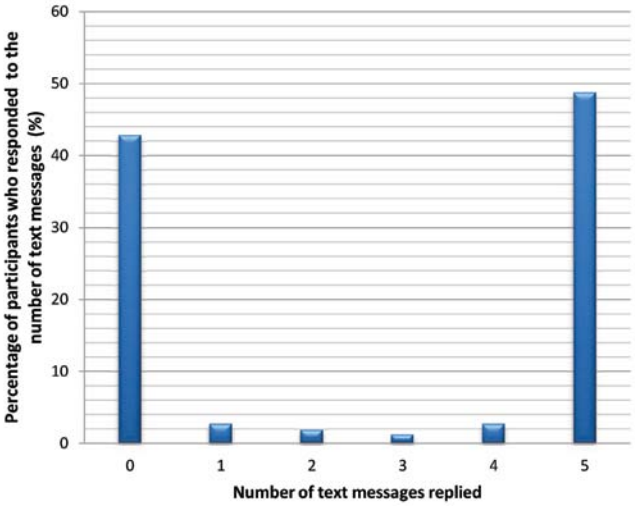

Figure 2. Percentage of mothers who replied to different numbers of text messages.

the fourth (κ = 0.13, 95% confidence interval 0.08–0.18 for minimum food frequency; κ ranged from 0.02 to 0.36 for all the seven food categories) and fifth questions (ICC = 0.06, 95% confidence interval –0.05–0.17).

The earliest time at which a mother completed the face–to–face survey was 7:55 in the morning and the latest time was 17:53 in the afternoon. We used the median time point of 11:45 in the morning to divide mothers into 2 groups. The text messaging survey started at 18:00. We calculated that the median time interval between the face–to–face and text messaging survey was 8.1 hours (Q1–Q3, 7.30–8.78) for the before 11:45 group and 3.4 hours (Q1–Q3, 2.1–5.3) for the after 11:45 group. **Table 3** shows the data agreement for the two groups. There were overlaps for the 95% confidence interval of the κ and ICC in data agreement for all the indicators between the two groups.

Table 4 presents IYCF indicators for responders of text messages calculated from face–to–face survey and text messaging survey. There were no significant differences for continued breastfeeding at 1 year ($P = 1.000$), continued breastfeeding at 2 years ($P = 0.688$) and minimum meal frequency ($P = 0.056$). However, the differences for minimum dietary diversity, minimum accepted diet and consumption of iron–rich or iron fortified foods were significant ($P < 0.001$).

Difference of IYCF indicators between the responders and non–responders of text messages

Table 5 illustrates IYCF indicators calculated for responders of text messages, non–responders and for all participants based on face–to–face survey database. There was no significant difference between responders and non–responders for all six indicators (P value ranging from 0.139 to 1.000).

DISCUSSION

Principal result

Our study examined the feasibility of using text messages to collect infant and young child feeding data. The response rate for the first question and the completion rate were 56.5% and 48.7%, respectively. Agreement was excellent for whether the child was breastfed yesterday (Q1), mod-

Table 2. Data agreement between the two methods

No. of text messaging questions	No. of pairs	Face–to–face (No., %)	SMS (No., %)	Total agreement (No., %)	McNemar test	P value	κ/ICC(95% CI)
Q1: Breastfed yesterday*	338	175 (51.8)	169 (50.0)	303 (89.6)	3.50‡	0.174	0.81 (0.75–0.86)
Q2: Times of drinking milk† yesterday	301	0 (0–2)	1 (0–2)	0 (–1–0)	–3090	<0.001	0.46 (0.37–0.55)
Q3: Iron–rich food and supplement yesterday*	224	171 (76.3)	175 (78.1)	180 (80.4)	0.36	0.546	0.44 (0.30–0.58)
Q4: Dietary recall:							
Grains, roots and tubers*	338	335 (99.1)	285 (84.3)	284 (84.0)	46.3	<0.001	0.02 (–0.04–0.08)
Legumes and nuts*	338	102 (30.2)	19 (5.6)	245 (72.5)	74.08	<0.001	0.15 (0.06–0.24)
Dairy products*	338	152 (45.0)	217 (64.2)	227 (67.2)	38.06	<0.001	0.36 (0.27–0.45)
Flesh foods*	338	196 (58.0)	68 (20.1)	196 (58.0)	115.38	<0.001	0.23 (0.16–0.30)
Eggs*	338	293 (86.7)	196 (58.0)	227 (67.2)	84.77	<0.001	0.26 (0.17–0.34)
Vitamin–A rich fruits and vegetables*	338	270 (79.9)	73 (21.6)	135 (39.9)	191.18	<0.001	0.10 (0.06–0.15)
Other fruits and vegetables*	338	283 (83.7)	152 (45.0)	199 (58.9)	116.74	<0.001	0.19 (0.12–0.26)
No. of food categories reported†	338	5 (4–6)	3 (2–4)	2 (1–3)	21420.5	<0.001	0.41 (0.32–0.49)
Minimum of diversity*	338	290 (85.8)	121 (33.1)	161 (47.6)	161.36	<0.001	0.13 (0.08–0.18)
Q5: Times of having solid and semi–solid food yesterday†	330	4 (3–4)	6 (4–7)	–2 (–3–0)	–16145	<0.001	0.06 (–0.05–0.17)

95% CI – 95% confidence interval
*Simple kappa (κ).
†Report median (interquartile range, IQR) for face–to–face, SMS and the difference (face–to–face way–SMS way), use pairwise Wilcoxon test, and intraclass correlation coefficient (ICC).
‡Extended McNemar test.

Table 3. Data agreement at different time intervals of the two surveys*

No. of text message questions	Total			Before 11:45			After 11:45		
	No. of pairs	Total agreement (%)	κ/ICC (95% CI)	No. of pairs	Total agreement (%)	κ/ICC (95% CI)	No. of pairs	Total agreement (%)	κ/ICC (95% CI)
Q1: Breastfed yesterday†	338	303 (89.6)	0.81 (0.75–0.86)	167	151 (90.4)	0.82 (0.74–0.89)	167	149 (89.2)	0.80 (0.73–0.88)
Q2: Times of drinking milk yesterday‡	301	0 (–1–0)	0.46 (0.37–0.55)	149	0 (–1,0)	0.519 (0.39–0.63	149	0 (–1,0)	0.36 (0.22–0.49)
Q3: Iron–rich food and supplement yesterday†	224	180 (80.4)	0.44 (0.30–0.58)	108	120 (81.5)	0.430 (0.22–0.64)	115	92 (80.0)	0.463 (0.28–0.65)
Q4: Dietary recall									
Grains, roots and tubers†	338	284 (84.0)	0.02 (–0.04–0.08)	167	136 (81.4)	–0.11 (–0.034–0.011)	167	145 (89.2)	0.063 (–0.08–0.20)
Legumes and nuts†	338	245 (72.5)	0.15 (0.06–0.24)	167	128 (76.7)	0.16 (0.019–0.30)	167	114 (68.3)	0.14 (0.03–0.25)
Dairy products†	338	227 (67.2)	0.36 (0.27–0.45)	167	114 (68.3)	0.39 (0.26–0.52)	167	110 (65.9)	0.32 (0.18–0.46)
Flesh foods†	338	196 (58.0)	0.23 (0.16–0.30)	167	98 (58.7)	0.23 (0.13–0.34)	167	96 (57.5)	0.23 (0.14–0.33)
Eggs†	338	227 (67.2)	0.26 (0.17–0.34)	167	107 (64.1)	0.24 (0.12–0.36)	167	118 (70.7)	0.273 (0.15–0.40)
Vitamin–A rich fruits and vegetables†	338	135 (39.9)	0.10 (0.06–0.15)	167	68 (40.7)	0.11 (0.06–0.17)	167	67 (40.1)	0.10 (0.04–0.16)
Other fruits and vegetables†	338	199 (58.9)	0.19 (0.12–0.26)	167	97 (58.1)	0.22 (0.11–0.32)	167	92 (55.1)	0.16 (0.07–0.25)
No. of food categories reported‡	338	5 (4–6)	0.41 (0.32–0.49)	167	2(1–3)	0.49 (0.36–0.59)	167	2 (1–3)	0.32 (0.18–0.45)
Min of diversity†	338	161 (47.6)	0.13 (0.08–0.18)	167	81(48.5)	0.16 (0.08–0.23)	167	79(47.31)	0.10 (0.03–0.17)
Q5: Times of having solid and semi–solid food yesterday‡	330	–2 (–3–0)	0.06 (–0.05–0.17)	165	–2(–4–0)	–0.01 (–0.17–0.14)	161	–2(–3–0)	0.17 (0.02–0.32)

95% CI – 95% confidence interval
*There were 6 caregivers interviewers recorded their responses by pen–and–paper, therefore the completed time wasn't recorded, and we deleted those in this part.
†Simple kappa (κ).
‡Report median (interquartile range, IQR) for face–to–face, SMS and the difference (face–to–face way–SMS way), use pairwise Wilcoxon test, and intraclass correlation coefficient (ICC).

Table 4. IYCF indicators for responders of text messages based on face–to–face and text messaging surveys

Number of indicators	No. of pairs	Face–to–face survey (%)	Text messaging survey (%)	Comparison	
				McNemar test	P value
1: Continued breastfeeding at 1 year	72	90.3 (n=65)	88.9 (n=64)	0.33	1.000
2: Continued breastfeeding at 2 year	98	41.8 (n=41)	39.8 (n=39)	0.67	0.688
3: Minimum meal frequency	217	73.7 (n=160)	65.9 (n=143)	3.66	0.056
4: Minimum dietary diversity	222	86.9 (n=193)	37.8 (n=84)	103.31	<0.001
5: Minimum accepted diet	215	54.4 (n=117)	20.9 (n=45)	52.90	<0.001
6: Consumption of iron–rich or iron fortified foods	225	60.0 (135)	33.3 (n=75)	40.00	<0.001

Table 5. IYCF indicators based on face–to–face survey

Number of indicators	Total		Non–responder of text messages		Responder of text messages		Comparison	
	No.	%	No.	%	No.	%	χ^2	P value
1: Continued breastfeeding at 1 year	127	89.8 (n=114)	55	89.1 (n=49)	72	90.3 (n=65)	–*	1.000
2: Continued breastfeeding at 2 year	174	43.7 (n=76)	76	46.1 (n=35)	98	41.9 (n=41)	0.31	0.578
3: Minimum meal frequency	451	74.9 (n=338)	234	76.1 (n=178)	217	73.7 (n=160)	0.32	0.567
4: Minimum dietary diversity	451	84.9 (n=383)	229	83.0 (n=190)	222	87.0 (n=193)	1.39	0.239
5: Minimum accepted diet	451	54.6 (n=246)	236	55.7 (n=129)	215	54.4 (n=117)	0.003	0.959
6: Consumption of iron–rich or iron fortified foods	451	56.5 (n=255)	226	53.1 (n=120)	225	60.0 (n=135)	2.19	0.139

*Fisher exact test.

erate for the times of drinking infant formula, fresh milk or yoghurt (Q2) and whether iron fortified food or iron supplement was consumed (Q3), and poor for 24–hour dietary recall (Q4) and times of eating solid and semi–solid food yesterday (Q5). Data agreement in the 8.1–hour time interval group and 3.4–hour time interval group was the same. Three IYCF indicators calculated from both the two surveys were not significantly different, whereas the other three were significantly different.

Response rate. Response rate is crucial for a successful text messaging data collection. Response rates reported in literatures were highly variable, ranging from 15% [20] to

100% [12]. A study evaluating the use of text messaging for infant feeding questions reported a 92.7% response rate in a cohort of women who recently delivered, asking about their current infant feeding practices and future feeding plans through text messaging [21]. The response rate in our study was moderate comparing with other studies on text messaging data collection, but much higher than our former study conducted in the same county, which had a completion rate of 27.9% in text messaging survey (our unpublished data). There were differences in methodology between the current and former study. Some possible reasons may explain the improvement of response rate. First, the supervisor in each team asked or checked the phone number with mothers, while the former study asked the village doctors to do this. Second, we asked interviewers to remind mothers to reply to our text messages, to explain in which format they had to reply to the text messages, and to tell mothers that they received ¥ 5 mobile credit if they replied to all our text messages. Third, we sent all five text messages simultaneously to mothers, while in the former study, we sent text messages separately. Finally, the number of the core text messaging questions was five, whereas seven for the former study.

We found that the proportion of mothers who responded but did not complete the survey was very low (8.5%) compared to the completion rate (48.7%) and the non–response rate (42.8%). Mothers were likely to not reply to any text message, or to reply to all five text message questions. This may indicate that initiation is very important to increase the response rate of a text messaging survey. We also provided 5 Yuan mobile credit to those who completed our survey and this may have been the reason for a high completion rate.

Low response rate of text messaging survey is very common and may reduce the sample representativeness. We compared the demographic characteristics of responders and non–responders of the text messaging survey and found no significant difference. In addition, we calculated the IYCF indicators for responders and non–responders of text messaging survey based on the face–to–face survey database and found that there were no significant differences for all six indicators. This may imply that a low response rate does not necessarily affect the survey results; however, more efforts are definitely needed to dramatically increase the response rate.

Data agreement and IYCF indicators. Data validity is an important issue in instrument development and provides information about the quality of measurements [22]. Whitford et al. [21] showed that a text messaging survey had an excellent agreement compared to a telephone interview to collect information on infant feeding. A study comparing telephone interviews and text message data collection for disease symptom reporting also acquired a high degree of agreement [11]. In our study, agreement for the five questions varied hugely. Agreement was excellent for whether the baby was breastfed yesterday, which suggests that this question could be used in future text messaging surveys. The other four questions had moderate to poor agreement, which implies more studies need to be carried out for data validity of these questions.

Some terms in the questionnaires were not easily understood by mothers, such as iron fortified food or iron supplement and solid food or semi–solid food. In face–to–face survey, the well–trained interviewers could explain this to the mothers. However, this was very difficult for the text messaging survey due to limited length and number of text messages. This implies that interviewer–administered face–to–face survey may still be better for questions which are hard to understand, whereas self–administered text messaging survey may have the potential to ask simple questions which require simple answers, such as Q1 in our study (Was your child breastfed yesterday during the day or at night?). We found that the number of food groups reported was significantly higher in face–to–face survey than in the text messaging survey. In the standard procedure for 24h dietary recall in face–to–face survey, the interviewer first asked the caregivers to recall activities and food intake for the child backwards; the interviewers chose the food group on the list based on caregivers' answer. When they finished the recall part, the interviewer went through every food group that the caregiver did not mention and asked whether the child ate that kind of food in the time period one by one. However, in the text message, we only asked the caregivers to self–report the food that the child ate once and this may explain the fewer categories of caregivers reported in the text messaging method

The reported times of eating solid and semi–solid food yesterday was significantly higher via text messaging. Caregivers may have had different views for solid and semi–solid food and overestimated the times that food was eaten. On the other hand, there might be interviewer bias in the face–to–face survey to underestimate the times, because children in this study were 12– to 29–month old and the interviews were likely to assume that the child eat 3–4 times solid and semi–solid food in a day.

In six IYCF indicators, the difference between the two survey methods for continued breastfeeding at 1 year and continued breastfeeding at 2 years were very small and not significant. These two indicators were based on the Q1, which had excellent agreement between the two methods. The difference for minimum meal frequency was large but not significant. The differences for the other three indicators were large and significant, much higher in face–to–face survey than in the text messaging survey. The calculation for these three indicators based on their responses to the

fourth question which involved the 24–hour diet recall. Caregivers reported fewer food categories from which their children ate via the text messaging method, which may help to explain the data inconsistency.

In the test–retest study, the choice of time–interval between the two tests was quite arbitrary. We did not define time–interval ahead, but divided them into two groups by the median time in which we completed the face–to–face survey. There was no difference for data agreement for all survey questions between the two groups (group with time interval between the face–to–face and text message survey of 8.1 hours (median) and 3.4 hours (median). Although the agreement for different recall time intervals for low back pain [11], sedentary time [23], and health related quality of life [24] were reported, no study explored a narrower time range for infant and young child feeding practices.

Strengths and limitations

To our knowledge, this is the first study exploring collection of standard WHO infant and young child feeding indicators by text messaging in rural China. Our study had some limitations. First, though using text messages as a data collection method was time efficient and user friendly, there was still work on coding the content of text messages and on setting up a text messaging database. Further research has to take this into consideration if text messaging method is to be used on a large scale. Second, the way of sending text messages may not be appropriate if there are some questions that needed to be skipped. Third, we did not evaluate mothers' acceptability of the methods which may have provided insights in the reasons for the fewer food categories they reported via text messaging method. Fourth, we could not validate whether a responder of text messaging survey was the same person who took part in our face–to–face survey. Fifth, old people in rural areas are usually unable to send text messages; therefore, text messaging survey could not be applied to grandparents of children.

CONCLUSION

Our feasibility study shows that text messaging survey had a moderate response rate compared to other studies on text messaging data collection and data agreement with face–to–face survey varied very much from question to question. Agreement for IYCF indicators calculated from the two methods also varied. Future research is needed to increase the response rate and improve the data validity of text messaging survey before it could be used.

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Authorship declaration: YZ designed the study. XD and WW jointly analyzed data and drafted the manuscript. XD, WW, QW, YL and XR collected data. MV, LC, RS, YZ and JC contributed to the critical review and revision of the manuscript.

Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organization for the submitted work; no financial relationships with other organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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Availability, prices and affordability of essential medicines in Haiti

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Background Haiti is the poorest country in the Western Hemisphere and faces numerous challenges, including inadequate medication access for its residents. The objective of this study was to determine the availability, prices, and affordability of essential medicines in Haiti and compare these findings to other countries.

Methods We conducted a cross–sectional nationwide survey in 2011 of availability and consumer prices of 60 essential medicines in Haiti using a standardized methodology developed by the World Health Organization and Health Action International. The survey was conducted in 163 medicine outlets in four health care sectors (public, retail, nonprofit and mixed sectors). Medicine prices were expressed as ratios relative to the International Reference Price. Affordability was calculated by comparing the costs of treatment for common conditions with the salary of the lowest paid government worker and was compared to available data from four Latin American countries.

Results For generic medicines, the availability in public, retail, nonprofit and mixed sectors was 20%, 37%, 24% and 23% of medications, respectively. Most of the available medicines were priced higher than the International Reference Price. The lowest paid government worker would need 2.5 days' wages to treat an adult respiratory infection with generic medicines from the public sector. For treatment of common conditions with originator brands (OB) purchased from a retail pharmacy, costs were between 1.4 (anaerobic bacterial infection) and 13.7 (hyperlipidemia) days' wages, respectively. Treatment of pediatric bacterial infections with the OB of ceftriaxone from a retail pharmacy would cost 24.6 days' wages. Prices in Bolivia, Colombia, Mexico and Nicaragua were frequently lower for comparable medications.

Conclusions The availability of essential medicines was low and prices varied widely across all four sectors. Over 75% of Haitians live on less than US$ 2.00 /day; therefore, most medication regimens are largely unaffordable. Inclusion of essential medications on the national formulary and working with organizations responsible for importing medications into Haiti, particularly drug donation agencies, are important first steps to increasing medication access.

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The World Health Organization (WHO) Essential Medicines List (EML) serves as a model for public supply and reimbursement of medicines. The list was first drafted in 1977 and expanded in 2007 to include essential medicines for children. The list highlights the most critical medicines for adult and pediatric patients [1]. Biannual revisions of the list take into account disease prevalence and the safety and efficacy of medicines, and since 2002, have adhered to rigorous standards of evidence [2]. The essential medicines concept may also be used to develop evidence–based clinical guidelines and a national medicines policy.

Data from national surveys have shown that access to essential medicines, particularly for children, is generally poor and prices can be unaffordable [3–8]. The reasons for the lack of access to essential medicines can include the absence of essential medicines policies, no regulated medicines, fragile supply systems, or out–of–pocket payments which make the medicines unaffordable. The EML can be adopted by countries according to their priority health care needs. National essential medicines lists (NEML) can be an important first step toward ensuring access to medicines since they can guide procurement, local licensing and manufacturing, and the quality use of essential medicines [9].

Haiti is the poorest country in the Western Hemisphere and, after the 2010 earthquake, has been facing significant challenges in meeting the health care needs of its residents [10]. The availability of essential medicines to address some of these needs is unknown. Haiti is a low income country with a GDP of US$ 726 per capita in 2011 [11]. About 54% of the population lives on less than US$ 1/day, and 78% live on less than US$ 2/day [12]. In 2010, Haitian life expectancy at birth was 60 years for males and 63 years for females compared with a regional average of 73 and 79 years for males and females, respectively [13]. In Haiti in 2011, mortality among children under 5 was 70 per 1000 compared to the rate of 19 per 1000 live births in the WHO Americas region [14]. The Haiti maternal mortality rate in 2010 was 350 deaths per 100 000 live births compared to a regional rate of 63 per 100 000 live births [13].

The poor health care conditions in Haiti are related to many factors including inadequate health care infrastructure, lack of health care providers and lack of health education. However, one of the least studied areas of health care in Haiti has been access to essential medicines. Many of the existing health problems facing Haiti can be treated or prevented by the use of essential medicines. Tuberculosis remains endemic and is a significant cause of mortality [15]. Malaria continues to remain a deadly problem in Haiti with a prevalence rate of 2–3% as of 2010 [16]. In 2010, diarrhea was found to be the fifth leading cause of death for Haitian children under 5, accounting for 7% of deaths [17]. PROMESS, the Program for Essential Medicines and Supply, is the central agency for the provision of essential medicines and supplies in Haiti. Under PAHO/WHO technical and managerial leadership since 1992, PROMESS is the main storage and distribution center that coordinates the efforts and contributions of international partners to improve access to essential medicines [18].

The objective of this study was to measure the availability, prices, and affordability of essential medicines in Haiti and compare these findings to other countries. These data provide evidence to guide policy ensuring that all Haitians have access to and the ability to afford life–saving medications.

METHODS

Study design and site

The cross–sectional survey of medicine availability and prices was conducted according to the WHO and Health Action International (WHO/HAI) methodology to facilitate comparisons with other countries. The survey of was conducted nationwide, in all ten regions of Haiti, in August 2011.

Selection of medicine outlets

Sampling of medicine outlets was conducted according to the WHO/HAI methodology, which has been shown through a recent validation study to yield a nationally representative sample [19]. Lists of health facilities and retail pharmacies were provided by the Ministry of Health and the Regional Health Departments for each survey region. Within each region, the main public hospital was selected. Then, four to five medicine dispensing outlets (eg, hospital out–patient medicine outlets, dispensaries) were selected from those within a 4–hour drive from the main hospital in each sector. Data on 59 medicines and one device was collected from 54 public, 35 private (retail), 39 nonprofit, and 35 mixed sector medicine outlets. Mixed sector contains outlets that are managed in a collaborative partnership between the Ministry of Health and a nonprofit group.

Selection of medicines

The WHO/HAI methodology specifies a core list of 14 global medicines and 16 regional medicines commonly used in the treatment of a range of chronic and acute conditions [19]. To facilitate international comparisons, the methodology also includes the specific dosage form and strength to be surveyed for each medicine.

In Haiti, all medicines from the WHO/HAI core lists were included in the survey [20]. An additional 28 medicines and 1 device identified as high priority essential medicines for children by the WHO Better Medicines for Children project were also included in the survey [21]. Enalapril 5mg, from the Haiti NEML [22] was also added to the sur-

vey to be evaluated alongside the Enalapril 10 mg from the regional core list. The list of survey medicines is provided in Online Supplementary Document, Table w1.

For each medicine in the survey, data were collected for the originator brand, highest priced generic equivalent, and lowest priced generic at each facility.

Data collection

The survey team consisted of 14 data collectors; 5 student pharmacists from University of California, San Francisco – School of Pharmacy, 6 students from State University of Haiti – Faculty of Medicine and Pharmacy (UEH–FMP), and 1 physician, 1 pharmacist, and 1 alumni from UEH. All survey personnel received training in survey methodology and data collection procedures prior to data collection. As part of the training workshop, two data collection pilot tests were conducted at retail medicine outlets which did not form part of the survey sample.

Data collection took place between August 4 and August 16, 2011. Supervisors checked all forms at the end of each day of data collection, and validated the data collection process by collecting data at 20% of the medicine outlets and comparing their results with those of the data collectors. Discrepancies were rare between data collectors and supervisors and were corrected when found. When at least 50% of the targeted medicines in any given medicine outlet were not found, an attempt was made to survey an additional outlet. All outlets were included in the analysis.

Data analysis

The availability of individual medicines is calculated as the percentage (%) of outlets where the medicine was found. Mean (average) availability was calculated for originator brands and the lowest priced generics for the basket of all 60 medications within each sector.

Data from Haiti were compared to data from Nicaragua, Mexico, Colombia, and Bolivia as these were the countries in the Americas region with available, recent essential medicines surveys. To facilitate cross–country comparisons, medicine patient prices obtained during the survey are expressed as ratios relative to a standard set of international reference prices: Median Price Ration (MPR) = Median Local Unit Price / International Reference Unit Price.

Thus, a median price ratio of 2 would mean that the local medicine price is twice that of the International Reference Price. Median price ratios were calculated only for medicines with price data from at least 4 medicine outlets. The exchange rate used to calculate median price ratios was 1 US$ = 39.6862 Gourdes; the commercial "buy" rate on the first day of data collection [23].

The 2010 International Drug Price Indicator Guide was used to determine the reference prices [24]. These reference prices are the medians of recent procurement prices offered by for–profit and not–for–profit suppliers to international not–for–profit agencies for generic products.

The affordability of treating seven common conditions for adults and two common conditions for children was assessed by comparing the total cost of the lowest priced generic medicines prescribed at a standard dose to the daily wage of the lowest paid unskilled government worker of US$ 5.04 [25]. For acute conditions, treatment duration was defined as a full course of therapy, while for chronic diseases, the affordability of a 30 days' supply of medicines was determined.

This study was reviewed by University of California, San Francisco, Committee on Human Research, and declared not to fit the definition of human research (exempt), reference number 11–06271.

RESULTS

Availability

Availability of medicines in the public, private, nonprofit and mixed sectors. Table 1 shows that the availability of lowest priced generic essential medicines varied by medicine, but was low across all sectors of health care. The mean availability of lowest priced generic medicines in the public, retail, nonprofit, and mixed sectors was 20%, 37%, 24% and 23% of medications, respectively. Originator brand availability was even lower across all sectors: public (2%), retail (5%), nonprofit (2%), and mixed (1.5%). Highest priced generics were found only in the private sector. The vast majority of outlets in all other sectors carried only one generic product per medicine. Therefore, there was insufficient data to make any comparisons to highest priced generics.

International comparisons of private sector availability. International comparison of the availability of nine originator brands in the private sectors was possible across Haiti, Nicaragua, Mexico, Colombia, and Bolivia. Compared to other countries, Haiti had the lowest originator product availability for atenolol (11% of outlets), ciprofloxacin (6%), and diclofenac (34%). The overall availability of the nine originator products that were surveyed across all countries was 13% of medicines in Haiti, compared to 19%, 47%, 23%, and 4% in Nicaragua, Mexico, Colombia, and Bolivia, respectively.

Table 2 shows the country comparisons of the availability of 12 lowest priced generic medicines in the private sector that were surveyed in all 5 countries. The average availability of lowest priced generics in Haiti was 73% for these 12 medications, compared to 84% in Nicaragua, 48% in Mexico, 79% in Colombia, and 71% in Bolivia.

Table 1. Availability of lowest priced generic formulation of each medication

Medicine name	Percent (%) of outlets where medicine was found			
	Public sector (n = 54)	Retail sector (n = 35)	Nonprofit sector (n = 39)	Mixed sector (n = 35)
Amitriptyline	1.9	11.4	7.7	2.9
Amlodipine	5.6	68.6	28.2	5.7
Amoxicillin	63	97.1	89.7	57.1
Amoxicillin Dispersible Tab	14.8	5.7	23.1	8.6
Amoxicillin suspension	50.0	51.4	46.2	48.6
Amoxicillin Suspension 125 mg/5 ml	68.5	97.1	56.4	80
Amoxicillin/Clavulanic Dispersible tab	0	2.9	0	0
Amoxicillin/Clavulanic Suspension	0	8.6	0	2.9
Atenolol	22.2	74.3	38.5	42.9
Atorvastatin	0	14.3	0	0
Azithromycin	9.3	65.7	15.4	11.4
Beclometasone Inhaler (100 µg)	0	0	2.6	0
Beclometasone inhaler (250 µcg)	0	2.9	0	0
Benzyl Penicillin Injection	3.7	0	2.6	5.7
Captopril	29.6	57.1	30.8	31.4
Carbamazepine Chewable Tablet	3.7	0	2.6	0
Carbamazepine Suspension	0	0	0	0
Ceftriaxone injection (1 g/vial)	51.9	71.4	51.3	51.4
Ceftriaxone injection (500 mg/vial)	7.4	2.9	12.8	2.9
Chloramphenicol Injection (1g/vial)	11.1	22.9	15.4	5.7
Chloroquine	55.6	77.1	71.8	62.9
Ciprofloxacin	57.4	91.4	76.9	77.1
Clonazepam	0	5.7	0	0
Clotrimazole topical cream	14.8	45.7	25.6	11.4
co–trimoxazole Dispersible Tablet	9.3	2.9	15.4	20
Co–trimoxazole suspension	51.9	62.9	64.1	71.4
Diazepam	25.9	45.7	30.8	40
Diazepam Rectal Solution	0	0	0	0
Diclofenac	46.3	85.7	43.6	42.9
Enalapril	35.2	85.7	41	37.1
Enalapril (5mg)	11.1	82.9	15.4	25.7
Ferrous Salt Suspension	3.7	5.7	0	8.6
Fluoxetine	5.6	14.3	0	2.9
Furosemide	38.9	77.1	48.7	60
Gentamycin Injection	5.6	0	2.6	0
Glibenclamide	29.6	80	41	54.3
Hydrochlorothiazide	38.9	65.7	35.9	34.3
Ibuprofen (200 mg)	24.1	31.4	56.4	40
Ibuprofen (400 mg)	66.7	82.9	61.5	80
Isoniazid	0	0	0	0
Metformin	20.4	62.9	15.4	8.6
Metronidazole	46.3	88.6	59	48.6
Morphine Dispersible Tablet	0	0	5.1	0
Morphine Oral Solution	0	0	0	0
Omeprazole	40.7	97.1	46.2	34.3
Oral Rehydration Solution (1 L)	48.1	45.7	69.2	80
Oral Rehydration Solution (500 ml)	0	0	0	5.7
Paracetamol suspension (120 mg/5 ml or 125 mg/5 ml)	48.1	77.1	51.3	60
Phenobarbital Injection	0	0	0	0
Phenobarbital Oral Liquid	3.7	8.6	0	0
Phenytoin	9.3	17.1	25.6	11.4
Phenytoin Chewable Tablet	0	0	0	0
Phenytoin Suspension	0	0	0	0
Procaine Penicillin Injection	3.7	8.6	0	2.9
Ranitidine	24.1	80.0	33.3	51.4
Salbutamol inhaler	25.9	85.7	35.9	37.1
Simvastatin	1.9	57.1	2.6	0
Spacer (for Inhalers)	0	0	2.6	0
Vitamin A	25.9	8.6	23.1	14.3
Zinc Dispersible Tablet	7.4	2.9	5.1	11.4

Prices

Consumer prices in public, private, nonprofit, and mixed sectors. Across all four sectors, the medicines in Haiti were sold at higher prices than the international reference price. Table 3 shows that consumer prices in Haiti were closest to the international reference price for originator brands sold in the public sector. Originator brands prices in the private sector in Haiti were 35 times the international reference price.

Table w2 in Online Supplementary Document shows median price ratios for selected lowest priced generic medications, by sector.

Table 2. Availability and median price ratios (MPR) of 12 essential lowest priced generic medications in Haiti compared to 4 neighboring countries

	Haiti		Nicaragua		Mexico		Colombia		Bolivia	
Medication (strength)	Availability (%)*	MPR	Availability (%)	MPR	Availability (%)	MPR	Availability (%)	MPR	Availability (%)	MPR
Amitriptyline 25 mg	11.4	13.3	51.6	11.2	0	N/A	93.2	6.4	50	8.3
Amoxicillin 500 mg	97.1	4.3	100	2.2	53.3	4.3	96.6	2.5	100	2.3
Atenolol 50 mg	74.3	15.9	61.3	4	6.7	N/A	11.9	10.1	73.3	6.15
Captopril 25 mg	57.1	10.5	93.5	4	86.7	5.5	96.6	1.5	0	N/A
Ceftriaxone 1 g/vial	71.4	5.5	90.3	3.6	73.3	6.6	49.2	3	93.3	1.1
Ciprofloxacin 500 mg	91.4	5.1	100	8	80	12.7	100	4.8	96.7	4.4
Co–trimoxazole 8+40 mg/ml	62.9	4.5	83.9	4.2	80	4.5	86.4	4	86.7	4
Diclofenac 50 mg	85.7	25.2	96.8	11.3	6.7	N/A	96.6	7.9	100	7.9
Glibenclamide 5 mg	80	20.4	83.9	10.4	46.7	5.2	91.5	7.3	90	13
Omeprazole 20 mg	97.1	4.2	96.8	6.3	80	9.3	94.9	2.2	96.7	3.3
Salbutamol 100 µg/dose	85.7	2.3	71	3	53.3	2.1	96.6	1.4	60	2.4
Simvastatin 20 mg	57.1	N/A	83.9	N/A	6.7	N/A	35.6	N/A	6.7	N/A

N/A – Not Available or Not Applicable
*Percent (%) of retail outlets with medication.

Medicines were not priced consistently in relation to their international reference price. In the public sector, half of the lowest priced generic medicines were priced at 3.4 (25th percentile) to 9.0 (75th percentile) times their international reference price. In the retail sector, half of the originator brand medicines were priced at 11.2 (25th percentile) to 47.4 (75th percentile) times their international reference price and half of the lowest priced generic medicines were priced at 4.4 (25th percentile) to 14.3 (75th percentile) times their international reference price. In the nonprofit sector, half of the lowest priced generic medicines were priced at 3.3 (25th percentile) to 10.2 (75th percentile) times their international reference price and finally in the mixed sector, half of the lowest priced generic medicines were priced at 3.1 (25th percentile) to 6.9 (75th days' percentile) times their international reference price.

International comparisons of private sector prices. As shown in Table 2, most of the 12 lowest priced generic medications were sold at higher prices in Haiti compared to Nicaragua, Mexico, Colombia, and Bolivia. On average, these medications were sold in Haiti at 10 times the international reference price, compared to seven times the international reference price in Nicaragua, 6 times the international reference price in Mexico and Colombia, and 5 times the international reference price in Bolivia.

Affordability

Affordability of medicines to treat common conditions. Table 4 shows that most of the lowest priced generics needed to treat 10 common uncomplicated conditions cost less than a day's wage in the public sector. Treatments costing over a day's wage include diabetes with metformin 850 mg (1.5 days' wages) and hypertension with captopril 25 mg (1.2 days' wages). However, given the low availability of medicines in the public sector, many patients must purchase medicines from the private sector.

Table 3. Median price ratios (MPR) of originator and lowest priced generic medicines by sector

	Type of medicine	
Sector	Originator Brand	Lowest Priced Generic
Public	1.6	4.8
Private	35	7
Nonprofit	N/A	4.3
Mixed	N/A	4.0

MPR – Median Price Ratio = median local unit price/international reference unit price, N/A = insufficient data available for calculation.

Table 4 shows that in the private sector, the affordability of the lowest priced generics varies from 0.2 to 5.3 days' wages. Treatments that cost more than one day's wage include diabetes with metformin 850 mg (1.7 days' wage), hypertension with captopril 25 mg (1.5 days' wage), and hyperlipidemia with simvastatin 20 mg (2.1 days' wage). Treatment of respiratory infection with ceftriaxone 1g/vial cost 5.3 days' wage. The most affordable standard treatments were those for treating chronic conditions such as asthma with salbutamol 100mcg (0.8 days' wage) and diabetes with glibenclamide 5 mg (0.8 day's wage). The most affordable standard treatments were those for treating acute conditions like respiratory infection with ciprofloxacin 500 mg and amoxicillin 500 mg (0.4 and 0.5 days' wage, respectively).

When originator brands are prescribed and dispensed in the private sector, several treatments cost well over one day's wage. Treatment of respiratory infection with ceftriaxone 500 mg and ceftriaxone 1g costs 24.6 and 28.0 days' wages, respectively, while treating arthritis with diclofenac 50 mg costs 9.0 days' wages.

We calculated the number of days' wages required to treat a family with 3 chronic conditions. To treat a mother's diabetes with 30 days of metformin, 1.5 days' wages are required. In addition, 1.2 days' wages are required to treat the father's hypertension with captopril for 30 days' and

Table 4. Number of days' wages needed for the lowest paid Haitian government worker to purchase standard treatments for adults and children in Haiti

For Adults (daily wage: 200 HTG (US$ 5.04/day)					
Disease condition and 'standard' treatment		Day's wages to pay for treatment			
Condition, drug name, strength, dosage form	Treatment schedule	Lowest priced generic – public sector	Lowest priced generic – private sector	Lowest priced generic – nonprofit sector	Lowest priced generic – mixed sector
Asthma					
Salbutamol 100 µg/dose inhaler	1 inhaler of 200 doses	0.7	0.8	0.6	08
Diabetes					
Glibenclamide 5 mg cap/tab	1 cap/tab ×2×30 days=60	0.8	0.8	0.5	0.6
Metformin 850 mg cap/tab	1 cap/tab ×2×30 days =60	1.5	1.7	n/a	N/A
Hypertension					
Atenolol 50 mg cap/tab	1 cap/tab ×30 days =30	0.4	0.9	0.6	0.8
Captopril 25 mg cap/tab	1 cap/tab ×2 30 days =60	1.2	1.5	1.5	0.9
Amlodipine 5 mg cap/tab	1 cap/tab ×30 days =30	N/A	0.8	0.5	N/A
Hyperlipidemia					
Simvastatin 20 mg cap/tab	1 cap/tab ×30 days =30	N/A	2.1	N/A	N/A
Atorvastatin 10 mg cap/tab	1 cap/tab ×30 days =30	N/A	2.6	N/A	N/A
Bacterial infection					
Ciprofloxacin 500 mg cap/tab	1 cap/tab ×2 for 7 days =14	0.4	0.4	0.4	0.4
Amoxicillin 500 mg cap/tab	1 cap/tab ×3 for 7 days =21	0.3	0.5	0.4	0.4
Ceftriaxone 1 g/vial injection	1 vial ×7 days =7 vials	2.5	5.3	4.2	3.5
Anxiety					
Diazepam 5 mg cap/tab	1 cap/tab ×7 days=7	0.2	0.2	0.1	0.1
Arthritis					
Diclofenac 50 mg cap/tab	1 cap/tab ×2×30 days =60	0.6	1.3	0.6	0.5
Ulcer					
Omeprazole 20 mg cap/tab	1 cap/tab ×30 days =30	0.8	0.8	0.7	0.5
Ranitidine 150 mg cap/tab	1 cap/tab ×2×30 days =60	0.9	1.4	0.9	0.8
For Children					
Bacterial infection					
Amoxicillin Suspension 125 mg/5 mL	Child up to 10 years: 125 mg (=5 ml)×3×7 days=105 ml	0.3	0.3	0.3	0.3
Amoxicillin Suspension 250 mg/5 mL	Child over 10 years: 250 mg (=5 ml)×3×7 days=105 ml	0.3	0.4	0.3	0.3
Co–trimoxazole 8+40 mg/ml suspension	5 ml twice a day for 7 days=70 ml	0.2	0.3	0.2	0.4
Pain/inflammation					
Paracetamol 24 mg/ml suspension	5-year-old child: 15 mg/kg ×20 kg ×4×3 days=3600 mg (=150 mL)*	0.5	0.6	0.4	0.5

*Weight of average 5-year-old old child=20 kg (Centers for Disease Control and Prevention, United States)

0.7 days' wages are required to treat the child's asthma. Thus, 3.4 days' wages, or US$ 17.14 per month, are required for the family.

International comparisons of private sector consumer prices of medicines to treat common conditions. Data were available to compare the median price ratios of treatment for adult respiratory infection with ceftriaxone 1 g/vial injection purchased in the private sector. Figure 1 shows that with either generic or originator brand formulations, the cost of the treatment in Haiti significantly exceeds that of the comparator countries.

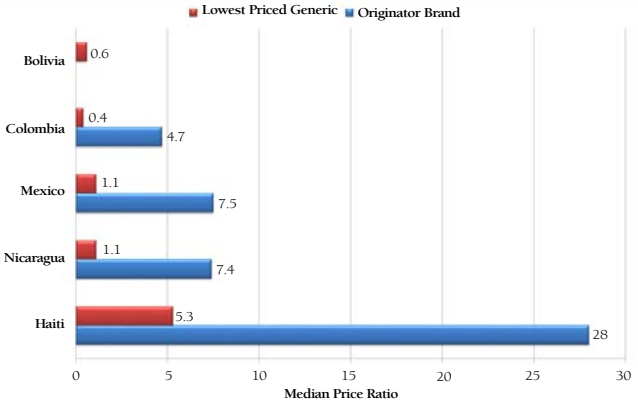


Figure 1. Median price ratios for treatment for adult respiratory infection with ceftriaxone 1 g/vial injection purchased in the private sector in five countries.

DISCUSSION

The availability of essential medicines for adults and children is poor across all sectors of health care in Haiti. Generic equivalents were the predominant product type available in all outlets, across all sectors. Prices varied widely across sectors and medicines for the treatment of common conditions are not affordable for the majority of Haitians.

These findings are consistent with studies of the availability and affordability of essential medicines in other countries [4,26–29].

A significant number of medicines were not found in any of the outlets – 16 medicines in the public sector, 13 in the retail sector, 15 in the nonprofit sector, and 19 in the mixed sector. Ten medicines were not found in any outlet in the public, nonprofit, and the mixed sectors. Eight of these 10 medications are used for management of pediatric conditions. Among the medicines that were lacking for pediatric use were phenytoin suspension and diazepam rectal solution for treatment of epileptic disorders, oral rehydration solution packets and amoxicillin/clavulanic acid dispersible tablets for bacterial infections.

Morphine formulations were not expected to be available at primary or clinic level of care or in retail settings. However, the surveyed formulations of morphine were also not found at secondary level regional hospitals or tertiary level hospitals. Although not surveyed, morphine in injection form was found only at the tertiary level public and nonprofit hospitals. The observed low availability may be due to the regulations placed on importation and/or manufacturing of opioid analgesics by the Haitian government [30]. Opioid availability and use has also been observed to be low after natural disasters [31]. Haiti has one of the lowest reported uses of opioid analgesics in Latin America and worldwide [30,32]. The low use of opioids for pain control may stem from the need for additional medical knowledge and biases that may exist for the treatment of pain with opioid based medications [30]. Furthermore, a comparative study found that the cost of opioids in developing countries was higher than in developed countries, which can limit availability and affordability in countries such as Haiti [33]. A recent WHO study indicated a strong positive correlation between development of a country and adequate access to opioids [30].

The prices of essential medicines in Haiti were considerably higher than the international reference price and there was a notable variability in prices across outlets in all health care sectors. The variability observed between outlets may have been the result of low market competition (as is the case outside of the capital city), the absence of price regulations on pharmaceutical products throughout the country, or differences in procurement and/or variability in price mark–ups throughout the distribution chain and in the areas surveyed. Further investigation of medicine pricing components is warranted.

In the public sector, the affordability of lowest priced generics was good for most conditions, with standard treatment costing up to one day's wage. However, low public sector availability may force some patients to purchase higher priced medicines from the private sector. In the private sector, some of the treatments, such as those for diabetes, hyperlipidemia, and hypertension, cost close to the daily wage of the lowest paid government worker, even when lowest priced generics are used. The majority of standard treatments were much less affordable when originator brands were purchased in the private sector.

Most Haitians earn much less than the lowest government wage, so even treatments which appear affordable were too costly for the poorest segments of the population. Given that 54% of the population is living below the international poverty line of less than US$ 1/day and 78% of the population in Haiti lives on less than US$ 2/day, essential medicines are financially out–of–reach for a substantial number of people [12].

Although treatment for some acute conditions such as bacterial infections may be affordable, the ongoing costs of treating chronic illnesses such as diabetes, hypertension, and hyperlipidemia may be insurmountable for many patients in Haiti [4,28]. According to the Pan American Health Organization (PAHO) the burden of chronic diseases in Haiti is high; a 2010 study in Port–au–Prince metropolitan area found hypertension prevalence of 48.7% and 46.5% in men and women, respectively [16]. The 2010 WHO report on noncommunicable diseases estimated the prevalence of overweight and obesity in Haiti at 32%, which increases the risks for chronic conditions such as cardiovascular diseases and diabetes [34]. The situation is further complicated by the observed lower availability of medications for treatment of chronic diseases vs acute conditions [26,28]. The monthly cost of long–term management of multiple chronic illnesses can exceed several days' wages of the lowest paid government employee. As shown in our example of a family of 3 requiring medicines for asthma, diabetes, and hypertension, the cost is US$ 17.14 per month and 54% of the Haitian population lives on US$ 30 per month. In addition, treatment costs were for medicines only and did not include the costs of consultation and diagnostic tests that place additional financial burden on patients [35,36].

Similar to adult medications, the availability of child–specific generic medicines far exceeded that of originator products across all sectors. Even so, most outlets only carried 3% to 50% of children's essential medications. This is consistent with a recent study on the availability of children's mediations conducted in 14 African countries, where availability of medications ranged from 15–75% of outlets, rarely exceeding 50% availability in any given outlet [8].

The affordability of treatments for children is no better than the availability. The leading causes of death of children under five in Haiti are diarrheal diseases, respiratory infections and malnutrition, and the under–five child mortality rate in Haiti in 2011 was 70 children per 1000 [14]. Amox-

icillin suspension is used to manage respiratory infections, and was the most common medication available for pediatric bacterial infections. However, the suspension was sold at, on average, three times the international reference price. Originator brand dispersible zinc tablets were widely available across sectors (except retail) for the management of diarrhea [37]. The cost of the zinc tablets was about 1.5 times the international reference price in the public sector, although zinc tablets were available free of charge in the public, nonprofit, and mixed sectors. However, oral rehydration solution (ORS) was available in only about half of the public outlets and in 80% of the mixed sector outlets; and when it was found, the ORS sold at 2.4 times the international reference price in retail outlets. It is unusual for zinc to be available more often than ORS and for it to be sold at a lower median price ratio [3,8]. It is possible that the availability of zinc in Haiti increased due to campaigns such as the one undertaken by UNICEF and its supporting partners in response to the cholera outbreak in October 2010 [38].

The comparisons with other Latin American countries suggest that the availability of lowest priced generics in Haiti is similar to that of the other countries. However, since medications in Haiti are priced higher than other countries, the affordability of those medications is much less. Further research is needed to identify the reasons for variation between different countries. Possible reasons include factors like size of the markets, capabilities of the national pharmaceutical manufacturing sector, the effect of taxes, duties, and mark–ups at national and local levels, and economic indicators. Such information would be useful for policymakers and governments in deciding what specific interventions can be made to make medicines more affordable and accessible in each country. Further studies and comparisons between high and low–income countries could also provide an evidence base for equitable or differential pricing strategies by multinational manufacturers, so that less wealthy populations can pay the same or less than wealthier countries for essential medicines.

We had suspected that the increase in medication donations after the 2010 earthquake in Haiti may have resulted in a sustained influx of essential medicines in Haiti, but this was not the case. Immediately after the earthquake, PROMESS played a key role in dispersing medicines as quickly as possible to where they were needed. However, in order for PROMESS to be effective in coordinating donations over the long term, it must have adequate staffing by pharmacists and logistics experts, as well as good communication with all donating agencies [39]. Furthermore, emergency drug donations are infrequently guided by essential medicines lists [40]. Donations that are not adherent to the WHO Guidelines for Medication Donations [41], which include the recommendation that donated medicines be essential medicines, can be more burdensome to the health care system than helpful, especially in an emergency situations [37,42–44]. Haiti is a participant in the PAHO Strategic Fund created by PAHO in 2000. Through the Strategic Fund, Haiti is eligible to receive technical assistance on how to review the supply management system and develop a coordinated procurement plan which could inform the coordination of donations [45].

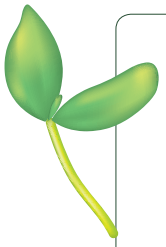
The use of the WHO/HAI medicine prices survey allowed us to measure prices and availability in a reliable and standardized way in order to make valid international comparisons. A further strength of the methodology is the multiple steps taken to ensure data quality [46]. However, our study has some limitations. Data on medication availability are influenced by market fluctuations and delivery schedules. Therefore data on medication availability at a single point in time may not reflect average monthly or yearly availability of medicines at individual facilities. In addition, the reliability of median price ratios is dependent on the number of supplier prices used to determine the median international reference price of each medicine. In cases where very few supplier prices are available, or where there is no supplier price and the buyer price is used as a proxy, median price ratio results can be skewed by a particularly high or low international reference price. A further limitation is that the list of medicines surveyed does not account for the availability of alternate strengths or dosage forms, or of therapeutic alternatives. Finally, the methodology does not include informal sectors, such as markets and general stores, as the quality of the medicines found in such sectors cannot be assured.

CONCLUSION

Although further investigation is required to obtain a more in–depth understanding of the causes and consequences of medicine availability and pricing [28], our findings show that several policies are required to make medicines more affordable and available in Haiti. First, a comprehensive assessment of the supply chain should be undertaken to identify reasons for low availability as well as areas where regulation of the procurement chain are appropriate [9,28]. Second, a routine assessment of the suppliers and the storage facilities around the country should be undertaken to ensure all essential medicines are being stocked and distributed to dispensing facilities in a timely and efficient manner [28].

The government of Haiti could require that its recently adopted National Essential Medicines list be used for purchasing and donation requests by all registered health agencies in the public, nonprofit, and mixed sectors as well nonprofit and for–profit organizations responsible for production and/or importation of medications into Haiti. PROMESS could play a key role in these coordination efforts. Restrict-

ing acceptance of mass donations to EML medicines after disasters is particularly important to avoid the use of dangerous or inappropriate medicines and their associated disposal costs [40]. As a participant in the Pan American Health Organization Strategic Fund, Haiti can receive technical support in procurement planning and programming to ensure continuous availability of essential medicines [47]. The government and partners should commit to reducing the price of the lowest priced generics across all medication dispensing sectors in Haiti. Interventions such as removal of duties and taxes on essential medicines are an option to achieve this goal [27–29,48]. An availability and pricing survey should be undertaken every 2 years to allow for continuous monitoring of impact and efficacy of any new policies put in place by government and health care partners in Haiti. Broad debate and dialogue are needed to identify how stakeholders can contribute to enhancing accessibility and affordability of essential medicines.



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Authorship declaration: HC designed project protocol, managed project, supervised and collected data; performed data analysis, produced initial manuscript; NSF assisted in protocol design and project management, supervised and collected data, provided input on manuscript, LB designed project protocol, supervised project, assisted in data analysis, assisted in writing manuscript.

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US medical specialty global health training and the global burden of disease

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Background: Rapid growth in global health activity among US medical specialty education programs has lead to heterogeneity in types of activities and global health training models. The breadth and scope of this activity is not well chronicled.

Methods: Using a standardized search protocol, we examined the characteristics of US medical residency global health programs by number of programs, clinical specialty, nature of activity (elective, research, extended curriculum based field training), and geographic location across seven different clinical medical residency education specialties. We tabulated programmatic activity by clinical discipline, region and country. We calculated the Spearman's rank correlation coefficient to estimate the association between programmatic activity and country–level disease burden.

Results: Of the 1856 programs assessed between January and June 2011, there were 380 global health residency training programs (20%) working in 141 countries. 529 individual programmatic activities (elective–based rotations, research programs, extended curriculum–based field training, or other) occurred at 1337 specific sites. The majority of the activities consisted of elective–based rotations. At the country level, disease burden had a statistically significant association with programmatic activity (Spearman's $\rho = 0.17$) but only explained 3% of the total variation between countries.

Conclusions: There were a substantial number of US medical specialty global health programs, but a relative paucity of surgical and mental health programs. Elective–based programs were more common than programs that offer longitudinal experiences. Despite heterogeneity, there was a small but statistically significant association between program location and the global burden of disease. Areas for further study include the degree to which US–based programs develop partnerships with their program sites, the significance of this activity for training, and number and breadth of programs in medical specialty global health education in other countries around the world.

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United States (US) – based academic global health programs have more than quadrupled in number between 2003 and 2009 [1]. These programs are characterized by research, clinical practice, or education that aims to improve understanding of the root causes of disease and better care delivery models to vulnerable populations across geographic borders. Global health education often includes material about the social, economic, environmental, historical, and political determinants of health, with a goal of health equity for all [2].

The rapid expansion of US global health programs has been multifactorial. Medical students and graduates are increasingly seeking to matriculate to residency and fellowship programs at academic centers which offer opportunities in global health. In one study, 92% of US surgical residents surveyed expressed interest in an international elective, and 82% noted they would prioritize a global health elective over any other [3]. Similarly, 90% of family medicine applicants considered global health as an essential program component [4]. From a program perspective, US global health training activities have been supported by increases in federal and foundation funding, and also figured prominently in recruiting of top applicants. In recent studies, both emergency and family medicine residency applicants ranked programs with global health rotations over those that did not offer global health rotations [4,5].

This rapid growth has been largely uncoordinated between training institutions and, therefore, is at risk of not necessarily aligning training focus to optimize the experience with the global burden of disease [6]. To date, there has been little consensus, guidelines or bench marks regarding what comprises core competencies in global health education and training [7,8].

While related work has examined the scope of US post–graduate medical specialty training in global health [9,10] and the relationship between national and international funding priorities and disease burden [11-13], to date there has been no comprehensive review of the variation in global health education and programmatic activity with respect to structure, disease focus, and geographic distribution. One method of obtaining such information would be to directly survey program directors as has been done in specific specialties. However, such surveys are challenged by very low response rates ranging from 25–59% [10,14,15]. Surveys of program websites have been performed previously [16] but none have specifically focused on global health training. To help address these gaps in the literature, we systematically collected characteristics of global health programs in US academic medical specialty training programs (residency) from web based program descriptions – a more sensitive method compared to survey – to catalogue existing programs as a first step towards understanding the breadth of global health education in different specialties; our secondary aim was to understand their distribution relative to the global burden of disease. Our goal was to characterize existing programs with respect to geography, specialty, and programmatic activity and to compare how these characteristics map to the global burden of disease.

METHODS

We systematically collected information available on residency program websites of seven major US graduate medical education specialties. Our search aimed to identify the presence of global health–focused training type of activity, and geographic location of these global health programs.

Program identification

Clinical residency training programs including internal medicine, pediatrics, general surgery, obstetrics and gynecology, mental health, emergency medicine and family medicine were compiled from the official Accredited Council for Graduate Medical Education (ACGME) website [17]. These programs are seven of the largest residency specialties in number of trainees and represented over 50% the total residents (N = 115 546) in the United States [17] in residency programs during academic year 2010–2011. Subspecialties, fellowships and joint clinical programs (eg, medicine/pediatrics) were excluded.

Search protocol

From January – June 2011, the following terms were entered (without punctuation) as separate queries using Google as a web search engine: "[Insert ACGME–listed program's name] global health [Insert Clinical Discipline] residency." The web page results were reviewed by one of several trained data abstractors (CR, RB, BB, VBK) for the first 20 search results [18,19]. Search protocols included an examination of web pages for all links that included any of the following keywords: "global health," "international health," "enrichment," "rural," "research," "vulnerable populations" or "health inequity." Data were also abstracted from every webpage linking the ACGME–accredited program to any of the following: "residency program," "clinical training," "research," "rotation" or "curriculum" related to global or international health. If the first 20 Google queries and the program website did not mention a program related to global health, then that program was coded as not having one. Programs listing only general and unspecified terms for electives were also excluded. The complete URL of each queried webpage was recorded. Fifteen percent of web searches were queried by a second reviewer (VBK) to confirm reproducibility of the information obtained. The primary function of this confirmatory check was to serve as a quality control mechanism, so agreement statistics were not calculated. Google searches were performed after clearing all browser cookies and signing out of Google accounts, so as to minimize the personalization of results to a specific user.

Program characteristic definitions

Global health training programs were evaluated for three types of programmatic activity: "elective–based rotations," "research programs" or "extended curriculum–based field training." Elective–based rotations were defined as clinical or educational activities of less than six weeks duration. Research programs required some component of data col-

lection or human subjects approval. Extended curriculum–based field training experiences were defined as engagements greater than six weeks and/or including a designated course of study concentrating on pertinent principles in global health. If an activity did not fit the previous three classifications or could otherwise not be characterized, it was listed as "other." Sites of programmatic activity were designated as country(ies) where any of the three above the programmatic activities occurred. To categorize these programmatic sites, we used the designated World Health Organization (WHO) list of countries and regions [20], specifying six regions: Africa, Americas, Eastern Mediterranean, Europe, Western Pacific and Southeast Asia. The study was completed before South Sudan's independence. The United States was excluded in final results as federal reimbursement of medical education is determined in part by activities in resource limited areas in the US; all US programs would meet the outlined criteria [21,22].

Analysis

The data were tabulated and summary descriptive statistics were used to compare program characteristics by region. Data from the 2004 WHO Global Burden of Disease assessment [20] were used for comparison to programmatic density by discipline, region and by country. To estimate the association between programmatic activity and disease burden, we calculated the Spearman's rank correlation coefficient between the two variables. We fit an ordinary least squares regression model to the data with the number of programs as the dependent variable and the burden of disease (per 100 000 DALYs) as the exposure of interest, with a cluster–correlated robust estimate of variance to account for potential clustering of observations within countries [23-25]. Disease–burden elasticity of program existence (ie, percent change in existing programs in relation to a percent change in disease burden) was evaluated at the means. In a sensitivity analysis, we constrained the intercept to be zero so as to mimic a process in which countries with no disease burden had no programmatic activity [12]. Statistical analyses were conducted using the Stata/MP software package (version 12.0, StataCorp LP, College Station, Tex., USA). Density of programs per country was categorized into seven defined cohorts (indicated in legend); these cohorts were then translated into a color–coded map using StatPlanet software by StatSilk (version 3.0, StatPlanet, Melbourne, Australia).

RESULTS

A total of 1856 ACGME residency programs were identified in internal medicine, pediatrics, obstetrics and gynecology (OB/GYN), general surgery, emergency medicine, family medicine, and psychiatry (**Table 1**). Three hundred–eighty (20%) of the total residency programs evaluated had documentation of global health training programs, with a total of 529 programmatic activities. The majority of programmatic activities consisted of elective–based rotations (292 [55%]), followed far behind by research programs (122 [23%]) and then extended curriculum–based field training (84 [16%]); thirty–one program

Table 1. Number of global health training programs and programmatic activities per clinical specialty

Specialty	Number of total ACGME residency programs per specialty	Number of residencies with global health training programs (% total in specialty)	Number of residencies with global health training programs (% total of 380 global health programs)	Total number of programmatic activities by specialty (mean programmatic activities per global health training programs in each specialty)*	Number (%) of programs with elective–based activities	Number (%) of programs with research programs	Number (%) of programs with extended curriculum–based field training	Number (%) of programs with other activities
Internal medicine	380	75 (20)	75 (20)	97 (1.3)	51 (53)	18 (19)	17 (18)	11 (10)
Pediatrics	198	65 (33)	65 (17)	101 (1.6)	59 (58)	20 (20)	19 (19)	3 (3)
OB/GYN	243	41 (17)	41 (11)	69 (1.7)	33 (49)	18 (26)	8 (11)	10 (14)
General surgery	246	21 (9)	21 (6)	33 (1.6)	14 (43)	12 (36)	5 (15)	2 (6)
Emergency medicine	155	64 (41)	64 (16)	105 (1.6)	59 (56)	31 (30)	8 (7)	7 (7)
Family medicine	451	97 (22)	97(26)	107 (1.1)	66 (62)	15 (14)	21 (20)	5 (5)
Psychiatry	183	17 (9)	17 (4)	28 (1.6)	10 (36)	8 (29)	6 (21)	4 (14)
Total	**1856**	**380 (20)**	**380 (100)**	**529 (1.4)**	**292 (55)**	**122 (23)**	**84 (16)**	**31 (6)**

ACGME – Accredited Council for Graduate Medical Education, OB/GYN – Obstetrics and gynecology

*The ratio represents the average number of programmatic activities per global health residency training program in a given specialty. A ratio of 1.3 means that, in internal medicine for example, 97 programmatic specialties over 75 global health training programs results in an average of 1.3 programmatic activities per program in that specialty.

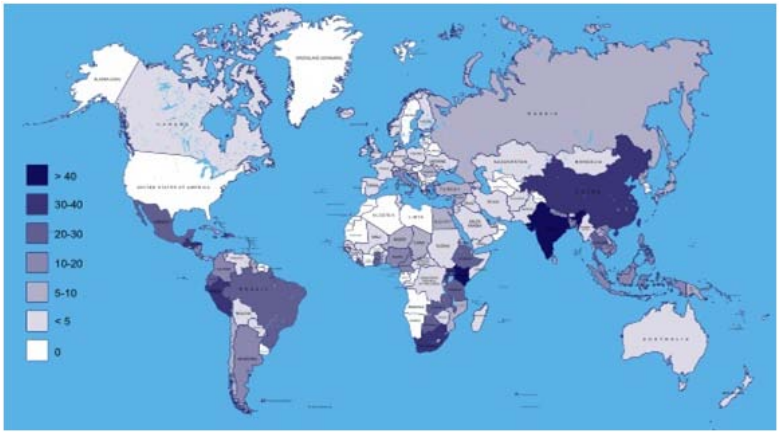

Figure 1. Density of programs by country. The legend on the left refers to the number of countries indicated by color. Each color corresponds to a set range of programmatic activities. Seventy–nine countries have fewer than 5 programmatic activities, 42 countries have only one program in the country and 53 have no reported activity. Websites offered insufficient detail to reliably discern the degree of bilateral exchange between programmatic activities. All of this programmatic activity was assumed to be based in partner country sites. The United States was excluded.

activities (6%) could not be categorized because the type of activity was not explicitly described. When disaggregated by discipline, all seven disciplines had more elective–based rotations relative to any other activity type. The greatest number of elective–based programs was in family medicine (66 [62%]), whereas the greatest number of research programs was in emergency medicine (31 [30%]). Psychiatry had the lowest number of programmatic activities of any specialty, followed closely by general surgery. Within specialties, family medicine (17 [18%]), pediatrics (19 [19%]), and internal medicine (21 [20%]) all had a high–frequency of extended curriculum–based field experiences. All seven specialties demonstrated all three types of programmatic activities.

Geographic location by country was available fully or in–part for 223 (59%) of the total 380 global health training programs identified which demonstrated programmatic activity in 141 countries in the world. Thirty–nine global health training programs referenced having both programmatic activity in specific countries as well as programmatic activity that was not assigned a specific country. One hundred and fifty–seven global health training programs did not specify the countries in which they were working. The 529 individual programmatic activities occurred at 1337 specific sites (**Table 2**). Africa had the greatest number of programmatic activities (384 [29%]) overall and for all residency disciplines except emergency medicine and family medicine. The Americas had an almost identical number of total programmatic activities (369 [28%]). The Western Pacific (128 [9%]) and Southeast Asia (124 [9%]), the regions with the third and fourth highest density of activities, had less than half of either the Americas or Africa. Evaluated by the number of programmatic activities in each specific country, Kenya had the

Table 2. Programmatic activity by World Health Organization (WHO) region and clinical specialty*

Region	Total number of sites with programmatic activities (% of total 1337 sites)	Number of sites with programmatic activity by specialty (% of total per clinical discipline)						
		Internal medicine	Pediatrics	OB/GYN	General surgery	Emergency medicine	Family medicine	Psychiatry
Africa	384 (29)	123 (3)	84 (35)	53(34)	18 (30)	41 (20)	36 (20)	29 (30)
Americas	369 (28)	102 (26)	78 (32)	36 (23)	12 (20)	48 (23)	72 (39)	21 (22)
Western Pacific	128 (9)	41 (10)	20 (8)	14 (9)	9 (15)	24 (12)	11 (6)	9 (9)
Europe	95 (7)	33 (8)	15 (6)	9 (6)	3 (5)	15 (7)	8 (4)	12 (13)
Eastern Mediterranean	41 (3)	14 (3)	7 (3)	2 (1)	0 (0)	11 (5)	5 (3)	2 (2)
Southeast Asia	124 (9)	36 (9)	24 (10)	14 (9)	4 (7)	23 (11)	10 (5)	13 (13)
Sub–total specified sites	**1141 (85)**	**349**	**228**	**128**	**46**	**162**	**142**	**86**
Unspecified sites	196 (15)	46 (12)	13 (5)	26 (17)	14 (23)	44 (21)	42 (23)	11 (11)
Total	**1337**	395	241	154	60	206	184	97

OB/GYN = Obstetrics and gynecology

*The total number of programmatic activities was mapped according to WHO region. One hundred and ninety–six programmatic activities (15%) could not be mapped to a specific country.

highest number with 60 different program activities followed by India (n = 50) and Haiti (n = 38) (**Figure 1**). Importantly, websites offered insufficient detail to reliably discern the degree of bilateral exchange between programmatic activities. All of this programmatic activity was assumed to be based in partner country sites.

At the country level (n = 193), there was a statistically significant correlation between burden of disease and programmatic activity (Spearman's $\rho = 0.17$; 95% CI, 0.03–0.31). Fitting a linear regression model, only a small proportion of the variance in programmatic activity could be explained (adjusted $R^2 = 0.03$) (**Figure 2**). Each 10 000 Disability Adjusted Life Year (DALY) increment (indicating an increase in disease burden) per 100 000 persons in that country was associated with the existence of approximately one additional residency program (b = 0.0001; 95% CI, 0.00002–0.0002). Expressed differently, a two–fold increase in DALYs per 100 000 was associated with a 41% (95% CI, 11.6–71.1) increase in the number of residency program activities within a country. Several countries had a far greater intensity of program activity than would be predicted on the basis of disease burden alone, most notably India, Haiti, and Honduras. In the sensitivity analysis, a regression model with the intercept constrained at zero yielded a similar estimate.

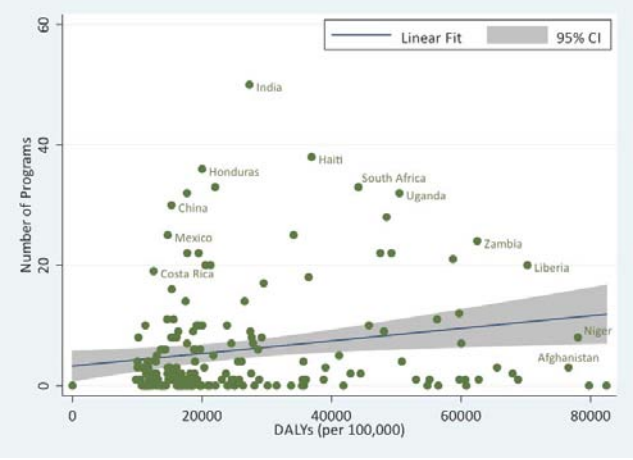

Figure 2. Intensity of programmatic activity by country–level burden of disease. Points above the fitted line represent countries that have a greater number of programs than predicted by our regression model, whereas points below the line represent countries that have fewer programs than predicted.

DISCUSSION

Our analysis found 20% of assessed US residency programs have global health programmatic activities and revealed a statistically significant correlation between country–level disease burden and the density of current US residency global health programs; this suggests that US residency program leadership feel there is a benefit from learning in a global setting and are directing resources to global health education. While the association between number of programs and disease burden for each country is statistically significant, there is substantial heterogeneity.

Global health programs span a broad range of clinical disciplines. They are more common, though, in general medical specialties such as internal medicine, emergency medicine, family medicine and pediatrics than more technically focused specialties such as obstetrics and gynecology or general surgery. The technical and service requirements of surgical training, including obstetrics and gynecology, may explain the paucity of programs in these fields. Surgery generally involves a complex care model requiring operating rooms, equipment, sterilization methods and anesthesia, many of which are absent or lacking in these global settings. Additionally, many surgical diseases have not been viewed traditionally as a public health problem and thus effort and funds have not been allocated as frequently as in other specialties [26]. Finally, there may be concern in domestic programs that electives abroad interrupt essential skill building.

We found few global health psychiatry programs relative to the global burden of psychiatric disease.

In resource–limited settings, neuropsychiatric disorders and suicides are a major cause of morbidity and mortality [27,28]. Compared to surgery and obstetrics, the paucity of global health psychiatry programs is less likely to be explained by technical and/or service requirements. However, the clinical practice of psychiatry relies more on cultural and language familiarity than other specialties. Accordingly, issues related to culture and language may pose a greater barrier to establishing psychiatry global health programs [29,30].

More than half of global health programmatic activity is rotation or elective–based and reflects a myriad of activities. The impact of "visitors" during elective rotations can be either positive, negative or somewhere in between. For example, elective rotations can occur at a site of long–term partnership with concrete supervision, goals and curricula and where they participate in the goals and mission of the site. Alternatively, residents may serve as "medical tourists" without integration into local systems. These latter programs can compromise both the resident's experience and the functioning of the recipient site. Brief elective rotations have demonstrated improved clinical skills, increased cultural sensitivity, better public health awareness, greater appreciation of resource utilization and a more in depth understanding of the challenges of delivering care in resource–poor settings among US–based rotators [7,31,32]. The benefits for host countries of these brief stints for trainees are poorly characterized. Ultimately, the investment and

dividends of each type of programmatic activity, whether elective–based, research or extended curriculum–based field training are broad. Each will have different impact on trainees from US institutions and the partner sites depending on level of funding, depth or partnership and priority setting. More research will be needed to characterize the potential benefits (or harms) of the programmatic activities.

With the constraint that educational programs require time to develop, we correlated the global health programmatic activity among residency programs in 2011 with the most recently reported global burden of disease data published in 2008. Our analysis revealed a statistically significant correlation between country–level disease burden and the density of current residency global health programs, suggesting that residency programs are directing resources to countries of greater need. However, the magnitude of association is small, and the policy relevance of this association is unclear. In the US national studies by Gillum et al. [12] and Gross et al. [13], 33–39% of the variance in National Institute of Health (NIH) funding could be explained by category–specific disease burden alone, whereas in our model only three percent of the variance in programmatic activity could be explained by country–level disease burden. Despite the statistical significance, the order–of–magnitude difference, however, is likely due to ad hoc rather than actively coordinated establishment of programs informed by priority–setting exercises such as those which have been performed for global child and mental health research [33-36]. As programs become more numerous and sophisticated, such studies could be convened by residency leadership bodies such as the American Association of Directors of Psychiatry Residency Training or the Association of Program Directors in Surgery. Long overdue, these studies could potentially provide valuable and systematic guidance to residency programs seeking to establish new training sites in order to maximize the collective impact on the global burden of disease [37].

While our study is able to characterize the distribution of global health programs by clinical discipline, the global burden of disease is not as easily partitioned. Many diseases may have multi–disciplinary care models such as malignancy, infectious diseases or trauma, or a clinical discipline such as family medicine might address multiple causes of morbidity and mortality. For example, conditions treatable by surgical intervention represent an estimated 11% of the global burden of disease [38-40] whereas according to our study, 9% of surgery residencies have global health training. Psychiatry represents 13% of the global burden of disease and one–third of years lost due to disability [41] but only 4% of global health residency training programs specifically address mental health. Future program growth should prioritize these disparities.

Our study was limited to US programs in medical specialty education and reflects a growing interest in global health engagement in the US. We believe this reflects a global trend based on known partnerships between institutions in resource limited countries and non–US institutions. For example, Bristol University in the United Kingdom partners with Mbarara University of Science and Technology in Uganda or the University of Naples in Italy has an exchange with Gulu University also in Uganda [42,43]. However, a direct comparison is difficult to make. Many international teaching and training partnerships remain scarcely recorded in the literature making it difficult to understand international trends in global health training programs. This phenomenon is especially notable among medical specialty education, or residency, programs. While there are publications on medical school global health education from North America, Europe, South America and the Pacific [9,44-49], literature for non–US residency education programs is scarce. Of note, a rare article on graduate medical education from Australia, reports that despite significant interest among trainees, global health education is not well developed [50].

There are several additional limitations to our findings. The internet–based protocol does not allow assessment of the degree of bilateral exchange, the depth of partnerships or opportunities for capacity building and education of partner trainees. It was not designed to capture the nature of programmatic activity in each country, the location of activity within each country, nor the details regarding sub–specialty (eg, infectious disease, cardiovascular disease or intensive care). Importantly, though not within the scope of this study, a deeper analysis of activities within countries would add to our findings. South Africa and India, for example, have very disparate burden of disease within the country. Understanding the location of activities for each program within certain countries would continue to refine the response to burden of disease.

The web based search protocol is limited in its sensitivity and will not capture global health activity of residencies which is not posted on their website [15]; activity may be informal or formal and not described at all or it possible that global health activities may be masked by generic terms such as "electives." While a systematic survey of residency directors or administrators could potentially provide more in depth and current description of global health activities, previous efforts at surveys have yielded inconsistent and poor response rates, which may introduce additional biases [10,14,15]. We recognize that some institutions may create institution–wide, or cross–campus, initiatives to organize global health programmatic activities that may make it more likely for a specific residency program to establish a global health program once another

residency program within the same institution has already established a global health program at a given site. However, we expect that such umbrella initiatives are rare relative to the overall degree of activity. It is also possible that these activities may not have been captured in our search results. For example, our estimates of surgical programs with global health training fall short of those captured in a 2009 study by Javaraman et al [14]. Finally, only seven residencies were evaluated out of approximately 30 clinical residency disciplines listed by the ACGME in 2011 [17]; while a defined sample, this large subset, reflects over 50% of all residents trained in the US in 2011. Because of the dynamic nature of programs or websites, updates may have been made since our initial data collection that were not included in this review. However, we believe this study provides an important overview and understanding of the trends in US medical specialty education and the global burden of disease.

Further evaluation will need to be conducted to better understand any additional granularity by specialty and/or subspecialty, as well as the depth of partnership between a US academic program and partner site and the amount of knowledge transfer. Equally, further evaluation would help elucidate the challenges to developing programs and international partnerships which may include cultural and language barriers, financial constraints, differing priorities between partner institutions or unsustainability. It will be important to better characterize the type of clinical education and investigation in each location.

CONCLUSION

Characterizing global health education among medical specialties in the US is the first step to standardizing global health training at this level in order to improve the experience for our trainees and to determine the extent to which US global health education reflects and addresses the global burden of disease. Identifying gaps in today's global health education will guide global health training to reduce the morbidity and mortality caused by the diverse etiologies of global burden of disease. The impact and benefits of these programs on trainees and vulnerable populations will need to be better assessed to balance the distribution of programs with respect to geography and disease burden and to better understand how to shape global health programs in medical specialty education.

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All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

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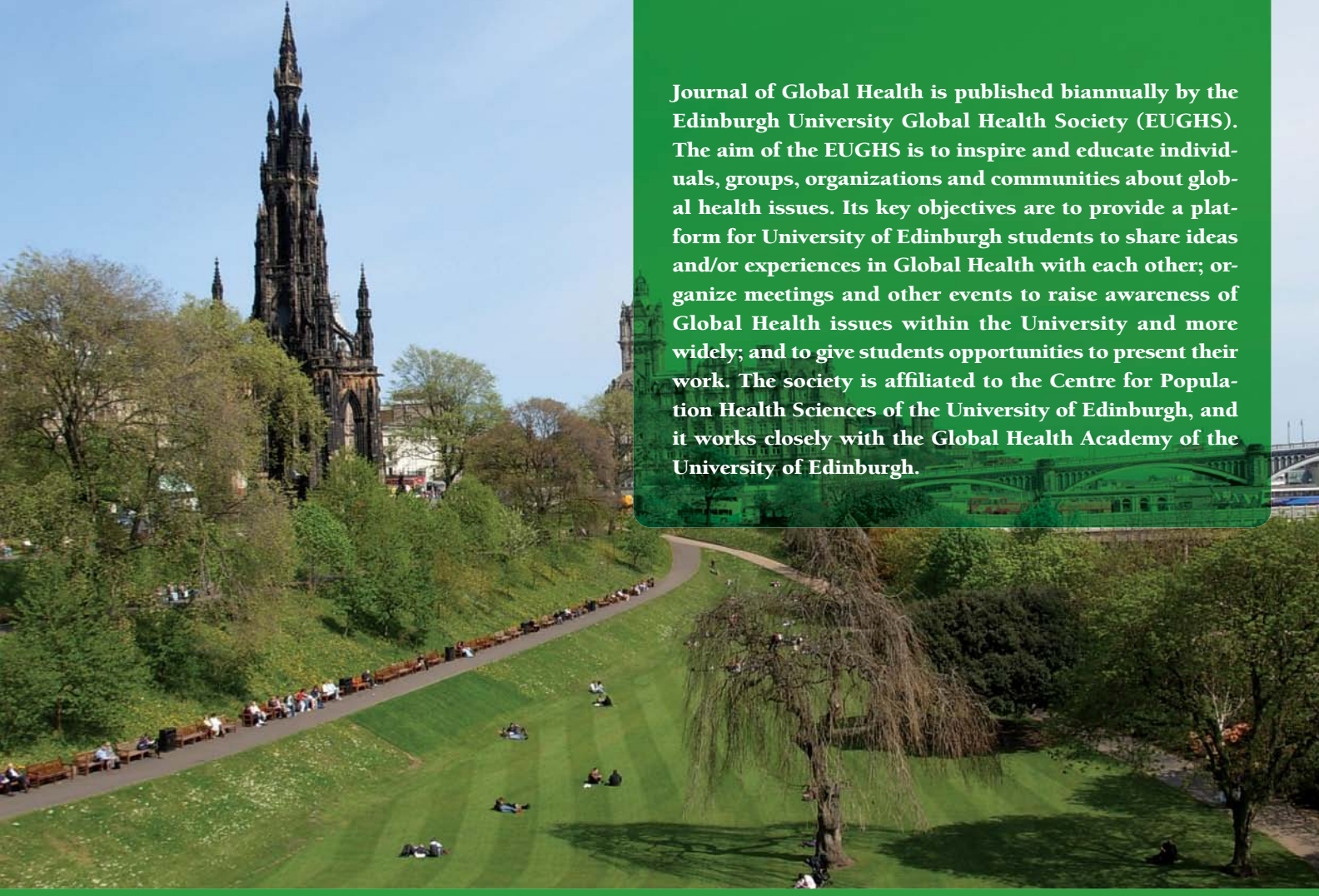

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