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GLOBAL HEALTH: SCIENCE AND PRACTICE
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EDITORIAL

The 6 domains of behavior change: the missing health system building block

Behavior is crucial throughout global health interventions. The discipline of behavior change offers distinct expertise needed across 6 different domains of behavior. Such expertise is in short supply, however. We will not have effective and sustainable health systems, nor achieve our ambitious global health goals, without seriously addressing behavior change.

The 2010 Global Burden of Disease (GBD) report makes strikingly clear the absolutely critical role of behavior to health. Despite the limitations of the GBD, it is remarkable that, for sub-Saharan Africa, for example, 15 of the top 20 health risk factors are predominantly behavioral, and the other 5 are highly influenced by behavior (Table).[1]

When we think about behavior, we tend to focus on predisposing individual, or ''lifestyle,'' behaviors with a strong relationship to health and disease. But behavior is crucial throughout health interventions. Indeed, the importance of behavior so permeates all of global health efforts—both preventive and curative—that interventions to influence behavior constitute an overlooked building block in health systems.

Below, I outline 6 domains of behavior and how each is important to our efforts to improve health. Although these domains often overlap, it is useful to consider each domain in turn because they are, to some extent, distinctive. And the principles and skill set of the behavior change discipline can be applied across them.

1. **Freestanding, personal or lifestyle behaviors.** These behaviors, such as those contributing to the risk factors listed in the Table, are behaviors that people can modify on their own, without the involvement of the clinical health system, to improve health or forestall illness. Examples in traditional global health priorities include: exclusive breastfeeding, hand washing, oral rehydration, wearing shoes to prevent helminth infection, and safe sexual practices. But free-standing behavior is also, or, arguably, even more, crucial to prevent noncommunicable disease and injury (NCDI)—behaviors such as tobacco and alcohol avoidance; use of seatbelts, motorcycle helmets, and clean-burning cook stoves; and adequate physical activity. Both over- and undernutrition affect the traditional and NCDI health priorities in numerous profound ways.
2. **Care-seeking behavior or demand.** Clearly, illness often drives people to seek care, but not always. Or, they seek it too late or from the wrong provider. Examples of crucial care-seeking include:
   - Timely access to more skilled delivery services, when complications occur during labor[2]
   - Early treatment of tuberculosis (TB), where it is estimated that the typical person with active TB infects 3 to 6 others[3]
   - Male circumcision for HIV prevention, which has not been readily accepted by older men, who are by far the highest-risk age group and epidemiologically critical[4]
   - HIV counseling and testing, where, unfortunately, many people at risk still forego testing[5]
   - HIV treatment, where many turn to faith healing in search of cure[6]
   - Family planning, where unmet need remains high in many countries[7]
   - Immunization, where ''vaccine hesitancy'' among parents is a major impediment[8]
   - Treatment of pneumonia and sepsis, especially in the early neonatal period, where recognition of early signs and quick treatment are essential[9]
3. **Client adherence and collaboration.** Once a therapy or other intervention is undertaken, the client's adherence or collaboration can be pivotal. After all, in TB treatment DOTS (Directly Observed Therapy – Short Course) was developed to assure adequate drug adherence. In family planning, discontinuation, especially of oral contraceptives and injectables, is a major reason for unintended

TABLE. Global Burden of Disease 2010: Top 20 Risk Factors, Sub-Saharan Africa

Rank	Risk Factor	Predominantly Behavioral	Strong Behavioral Contribution
1	Alcohol	X	
2	High blood pressure		X
3	Obesity	X	
4	Suboptimal breastfeeding	X	
5	Tobacco	X	
6	High blood glucose		X
7	Household air pollution	X	
8	Diet low in fruits	X	
9	Childhood underweight	X	
10	Iron deficiency	X	
11	Physical inactivity	X	
12	Drug use	X	
13	Diet high in sodium	X	
14	Intimate partner violence	X	
15	Diet low in vegetables	X	
16	Diet low in nuts and seeds	X	
17	Vitamin A deficiency	X	
18	Unimproved sanitation		X
19	High total cholesterol		X
20	Lead exposure		X

Source: Lim et al.[1]

pregnancies. In HIV prevention, failure to use condoms correctly and consistently allows infection, while in HIV treatment discontinuation of antiretroviral (ARV) drugs leads to mortality. In malaria prevention, the success of bed nets depends on people, especially the most vulnerable, sleeping under them. Helmets protect only the cyclists who wear them. And clinical approaches to hypertension and diabetes depend greatly on adherence, often to more than one drug. Moreover, poor adherence to antimicrobials leads to drug resistance, which undermines efforts for the entire population.

4. **Provider behavior.** Providers are people, too. We expect them to be competent, caring, and hardworking, but they have values, motivations, misconceptions, capabilities, constraints, social norms, and other priorities like anyone else. What they do and don't do can absolutely make or break many health programs. For example, poor provider performance in IMCI (Integrated Management of Childhood Illness) stems from a variety of behavioral factors including providers' beliefs and misunderstandings, cultural factors, profit motives, negligence, and forgetfulness.[10] In malaria care, providers' propensity to treat any fever as malaria is dysfunctional.[11] Many providers continue to treat non-bloody diarrhea with inappropriate antibiotics.[12] In family planning, many providers avoid IUDs,

partly because they lack confidence in their skills and inserting IUDs is time-consuming.[13] Providers also manage their workloads partly by regulating who and how many clients they see.[13] And clinicians in general are ill-prepared and ill-disposed to most counseling, despite counseling's often pivotal role.

5. **Pro-social and anti-social behavior.** These are behaviors that influence the health of the community or society at large. They include a wide variety of positive behaviors, such as covering one's mouth when coughing, using latrines, vaccinating one's chickens against avian influenza, and installing traffic-calming devices such as speed bumps, but also negative ones, such as reckless driving, generating air pollution, and even terrorism. These behaviors could be grouped with the first category, the freestanding ones, but typically they require different appeals, transcending appeals to self-interest.
6. **Policy and priority setting.** The behavior of policy makers clearly has a profound influence, notably on funding levels. But programmatic policies are important, too, driving what interventions are prioritized, how they are delivered, the way work is organized, who does what, what gets measured, and what gets rewarded. To some extent, policy is influenced by the medical culture of physicians and other health professionals, who typically manage and influence health programming. A common resulting problem is the preference for curative and clinical services over key prevention interventions. Another is resistance to task shifting, such as provision of simple but vital drugs and contraceptives by community health workers. Similarly, public attitudes are important. Clearly, general concern about HIV has helped galvanize the effective response. In contrast, fatalism and acceptance of maternal mortality as a ''normal'' occurrence has impeded maternal health initiatives.[14]

APPLYING COMMON PRINCIPLES OF BEHAVIOR CHANGE ACROSS THE DOMAINS

Why is appreciating these domains important? First, success in many global health priorities requires addressing multiple domains collectively. For example, good ''combination'' prevention in HIV calls for reducing sexual risk-taking and correct use of condoms (domains 1, 3, and 5), initiation and adherence to ARV drugs (since ARVs inhibit transmission) (domains 2 and 3), good counseling to support these behaviors among clients (domain 4), building demand for male circumcision and HIV testing (domain 2), and adequate funding and enlightened policies such as task shifting to support all of it (domain 6). In this issue of GHSP, Kamhawi et al. address 3 domains—promoting client demand (2), improving provider counseling (4), and supporting continued successful use (3)—in their intervention to improve use of family planning.[15]

At the same time, although each domain has its own characteristics, behavior change is a distinct discipline with its own approaches and skill sets that apply across the domains. Briefly, its components include:

- Understanding thoroughly the intended audiences, often through formative research
- Tailoring approaches to those audiences
- Using multiple vehicles of messaging and learning
- Appealing effectively to both heart and mind
- Promoting sustained behavior change, including building health literacy and positive habits
- Addressing key family members and communities and the social norms that they help to establish
- Including structural approaches that support positive behavior (for example, tobacco tax,

Two boys in Madagascar use soap and a water-saving ''tippy tap'' to wash their hands.

phone text medication reminders, and performance checklists for providers)

- Addressing incentives
- Measuring impact and making adjustments on a continuing basis

We can apply this behavioral expertise across all 6 domains and promote synergy. But behavioral expertise is in precious short supply, especially in developing countries. We need to expand and strengthen that expertise in institutions and to foster competent behavior specialists, but also to increase the behavioral expertise of all health cadres.

Any health system worth its salt must address the missing building block of behavior change in a vigorous way. We cannot achieve our ambitious global health goals without it. *– James D. Shelton, Editor-in-Chief*

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EDITORIAL

Making the most of food aid to help prevent child and maternal deaths

Advances in child nutrition over the last several decades are creating momentum for a programmatic push to reduce undernutrition worldwide. The contribution of food aid may be small, but, nonetheless, U.S. food aid policy should be revamped to benefit more effectively and more efficiently the children and mothers in need.

The recent series on nutrition in *The Lancet,*[1] together with a paper by Tappis et al.[2] in this issue of GHSP, provide an opportunity to reflect on the great progress in nutrition that has been achieved in the past few decades. Child survival and nutrition statistics tell a compelling story of both the accomplishments and also the challenges. Despite alarming increases in the numbers of overweight or obese children, undernutrition among children continues to decrease in much of the world. According to the *Lancet* series, the estimated number of children under 5 years who are stunted has steadily dropped, from 253 million in 1990, to 178 million in 2005, and to 164.8 million in 2011.[1] These worldwide decreases are led by historically unprecedented improvements in Latin America and parts of Asia, especially China and Southeast Asia. The decline in numbers globally has occurred while global population has grown by 31% since 1990. Unfortunately, however, the numbers of stunted children in sub-Saharan Africa continue to increase.

Specific nutrition and health interventions probably have played only a supportive role in the decline in global numbers. The combination of greater economic opportunities, education, gender and social equity, political engagement, and social protection; improved infrastructure; and public nutrition and health programs has saved lives and changed the planet. This has been the case in countries such as Brazil, China, and Thailand, and even in developed countries over the last 100 years.

Consensus is now emerging that concerted programmatic actions can successfully address undernutrition and, increasingly, overnutrition and that we know what the priority actions are. The global development agenda is seized with the belief that "…*we know what to do; let's just do it*." This has a familiar ring to it, and, as the *Lancet* series attests, along with the communication buzz, there is enthusiasm at the United Nations, in nongovernmental organizations (NGOs), and at many levels of governments in high- and low-income countries[3] to take action to prevent or even eliminate the undernutrition that affects billions of people.

KEY ROLE OF NUTRITION

The goal of ending preventable child and maternal deaths has taken on unprecedented priority and attention on the global health stage.[4] The *Lancet* series estimates that about 45% of child deaths and almost the same proportion of maternal deaths have underlying nutritional causes, with suboptimal breastfeeding alone accounting for 11% of child deaths.[1] And the *Lancet* series, along with the Scaling Up Nutrition agenda (http://www.scalingupnutrition.org) and many others, have identified a range of higher-impact interventions for infants and children, women of reproductive age, pregnant women, and, significantly, adolescents (Table).[5] These interventions have been selected based on studies that show a measurable and scalable impact. They are the starting point for determining what, either as a single effort or, preferably, in combination, is appropriate for the setting in which you are working.

ROLE OF FOOD AID

When we consider what can be done and how it can be supported, development assistance or aid is often the main focus of debate. Levels, targets, accountability, governance, transparency, and messaging are all part of the discussion.

Food assistance is an important part of the U.S. aid budget, contributing to nutrition, health, and agricultural programs in many recipient countries. Assistance for young children and their families is now the mainstay of food aid. Globally, direct food transfers

TABLE. The 10 Key Interventions for Women and Children[a]

Optimum Maternal Nutrition During Pregnancy

1. Periconceptual folic acid supplementation or fortification
2. Maternal balanced energy protein supplementation
3. Maternal multiple micronutrient supplementation in pregnancy
4. Maternal calcium supplementation

Infant and Young Child Feeding

5. Promotion of breastfeeding
6. Appropriate complementary feeding

Micronutrient Supplementation in Children at Risk (ages 6–59 months)

7. Preventive zinc supplementation
8. Vitamin A supplementation

Management of Acute Malnutrition

9. Management of severe acute malnutrition
10. Management of moderate acute malnutrition

[a] Based on their ability to save lives and be most cost-effective, assuming 90% coverage in the 34 high-burden nutrition countries.
Source: Adapted from Bhutta et al.[5]

have a somewhat minor role in addressing undernutrition overall, but they have a role with certain vulnerable populations that is essential to ending preventable child and maternal deaths. Food assistance is one resource considered only briefly in the *Lancet* series, and yet it is often placed by politicians and advocacy groups next to development assistance as worthy and needed. Cash transfers and in-kind assistance is covered in the series, but except for the case of emergencies, food aid receives cursory attention.

Food aid used in non-emergency settings carries with it decades of debate as to whether it is inefficient and even damaging to the recovery of local agriculture-based economies. The reasons for its persistence are many, reflecting more the domestic policy environment than the value or effectiveness of the food aid per se. As a continuing resource for improved nutrition and food security, food aid needs to work better and differently. In their paper in this issue, Tappis et al.[2] offer a case study of some of the challenges in a U.S. food aid program. The authors document the logistic and management experiences that faced NGOs implementing a development, or non-emergency, food aid program in South Sudan both before and after independence from Sudan on July 9, 2011.

By recounting the flow of food aid and the missteps that occurred, the authors argue for more flexibility in the rules that govern the procurement, movement, and programming of U.S. food aid. They also join many others in suggesting that more local procurement of commodities in the country or region will improve efficiency, improve dietary diversity and quality, and support local agriculture. The local procurement of foods, the authors argue, would diminish concerns over the likely presence of genetically modified (GM) foods, such as soy and corn, in the U.S. food aid basket. Setting aside the issue of GM foods' benefits or otherwise, the description of the food aid program in an unstable region does illustrate some of the many limitations and challenges that come with the food aid program, which is part of the massive U.S. Farm Bill.

STATUS OF FOOD AID REFORM

Every 5 years or so, the U.S. Congress renegotiates the Farm Bill, which is the authorizing legislation for the sprawling and symbiotic food and agricultural ecosystem that drives domestic and global food policies and programs. As I write this editorial, the current round of reauthorization is in legislative limbo, and stakeholders; lobbyists from agriculture, food manufacturing, and transportation industries; and implementers such as the World Food Programme and NGOs are making vigorous efforts to influence the specifics in the bill being crafted by the powerful U.S. House and Senate Agricultural Committees.

Understanding the specifics of this US$955 billion annual behemoth, especially as it relates to health- and nutrition-related support, requires patience and motivation. The bill typically funds the domestic U.S. Food Stamps program (now called Supplemental Nutrition Assistance Program, or SNAP) and food aid used in emergency and non-emergency programs in many parts of the world. The most recent House version of the Farm Bill has removed the provision for the SNAP program to facilitate passage of the remaining bill swollen with subsidies for domestic agricultural programs. Understanding the dynamics of the evolving

Farm Bill will help us understand some of the challenges in the South Sudan example.

The United States continues to supply the global relief and development effort while insisting on mostly U.S.-grown, U.S.-processed, U.S.-packaged, and U.S.-shipped food. In both emergency and non-emergency situations, health clinics and other sites are still distributing food in the form of U.S. commodities, such as fortified corn-soya blend, vegetable oil, and legumes. Without question, emergency food will need to come from afar in times of clearly defined acute food shortages, as is sometimes the case after an extended drought, other weather-related event, or civil unrest. But, for a sack of a blended cereal to travel 7,000 miles and be given to a caregiver constitutes an inefficient use of the resources of many people, including those of the health worker and the caregiver.

WHAT'S NEEDED FOR FOOD AID REFORM

The food aid program and the Farm Bill have been the constant subject of analysis and recommendations for reform by economists,[6] policy analysts, journalists,[7] and others.[8] Proposals by the U.S. Agency for International Development (USAID) and others[9] include:

- Allowing greater flexibility in what is funded and how it is funded to provide flexibility in programming and more rapid responses—a move away from a tied, commodities-only approach
- Pairing in-kind food aid procurements from the United States with the use of cash-based interventions such as food vouchers and local and regional procurement from developing countries
- Ending the costly and inefficient process of monetization, or selling U.S. food aid commodities in affected and neighboring countries to raise cash for local programs

The United States is still committed to supplying food, but the almost 60-year-old program is no longer a surplus commodity program helping to distribute food that would otherwise be lost. It is one of the many entrenched federally funded entitlement programs managed out of government agencies in Washington, DC, led by a range of interest groups and lobbyists.

Nevertheless, the reform proposals from USAID and others clearly would be a major step in the right direction. The need is to examine closely the use of U.S. commodities in food aid, especially for the health and nutrition non-emergency or development programs. There is less need to revamp the provision of life-saving food and health care to vulnerable populations affected by natural and man-made disasters.

With the renewed emphasis on nutrition, its champions challenge us to move forward with a wide array of actions to reduce over- and under-nutrition. These advocates for nutrition action from governments, UN agencies, academies, civil society, food manufacturers, and others therefore should champion an effort to refocus food aid to benefit most those it claims to help. Food aid is only a small part of the overall effort to end preventable child and maternal deaths; nonetheless, U.S. food aid policy needs to reflect the good intentions of its providers, the American people, and also an economic and humanitarian rationale. *– Bruce Cogill, Associate Editor for Nutrition*

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GLOBAL HEALTH: SCIENCE AND PRACTICE
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EDITORIAL

Focusing on implementation: the power of executing many small advances well

Success often comes through many small, incremental, well-executed improvements.

The highly regarded business classic *Good to Great*[1] found that one ingredient of highly successful businesses is pursuing and refining their core business year after year through incremental improvement and execution. So, too, in global public health. Yes, we have "game changers" in global health, to a degree, such as chlorhexidine for neonatal cord care, insecticide-treated bed nets, oral rehydration solution, contraceptive implants, pneumococcal vaccine, and even task shifting. But real success with these and dozens of other more modest interventions rests with persistent execution, often involving many painstaking steps.

This issue of GHSP provides some examples:

- **MCH programming.** Hodgins argues that maternal and neonatal health approaches need to shift from "grand strategies" to focus more on implementation content and quality, designed and carried out by informed, empowered managers responding to local situations.
- **Improving contraceptive method mix.** Family planning provides a good example of programming that has tended to succeed through steady execution over many years. Ross et al. describe how expanding the contraceptive method mix has contributed to that success and argues for the value of continuing to do so.
- **Provider behavior.** Providers and their behavior are key program ingredients. Kim et al. describe their methodology for improving antiretroviral service delivery in Zambia using the Standards-Based Management and Recognition approach. Their rather intensive intervention produced clear but fairly modest improvements. Provider behavior remains a realm needing more attention.
- **Family planning counseling.** Kamhawi et al. document a robust approach to reaching family planning clients, involving extensive outreach as well as provider training and job aids to improve counseling. They, too, found rather modest gains in family planning use.
- **mHealth.** Labrique et al. describe the vast programmatic landscape for potential mHealth applications. Paudel et al., as one example, document clear but modest and incremental gains from using tablet computers for the recent Nepal Demographic and Health Survey. So far, the experience with mHealth strongly suggests that advances will come not so much through any single major, transformational breakthrough, but rather through many adapted applications to address local problems, in a manner following the "diffusion of innovation" model.

At GHSP we are committed to illuminating and applauding the crucial and often hard work of program implementation, both large and small, and we will continue to spotlight it. – *Global Health: Science and Practice*

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GLOBAL HEALTH: SCIENCE AND PRACTICE
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VIEWPOINT

Achieving better maternal and newborn outcomes: coherent strategy and pragmatic, tailored implementation

Stephen Hodgins[a]

Maternal and newborn health program effort needs to: shift from mere *contact* to the actual *content* or substance of care; respond better to local context; ensure delivery of all key interventions needed during pregnancy, labor and delivery, and postnatally; and actively monitor performance to manage and improve programs.

With the "Every Woman, Every Child" global initiative[1] and the "Global Strategy for Women's and Children's Health" implemented under the auspices of the United Nations Secretary-General,[2] there are now unprecedented political priority and resources available to drive down global maternal and newborn deaths. Although this is certainly welcome, we risk squandering this opportunity if we continue business as usual. Several features of our current efforts are bogging us down, but there is a way forward.

WHAT IS THE PROBLEM?

Grand, Relatively Content-Free, One-Size-Fits-All Strategy

During the late 1990s and the early years of the new millennium, contesting camps in ***maternal health*** argued for approaches centered either on provision of: (1) tiered obstetrical services targeting an expected 15% or so of deliveries in which complications might be expected (Emergency Obstetrical Care), or (2) routine care for all deliveries by health care workers with midwifery skills (Skilled Birth Attendance).

Over the past half-decade, the dust from these earlier scuffles has settled; indeed, global leaders in maternal health have been advocating a more nuanced, multipronged approach. However, the one clear message emerging from essentially all global maternal health guidance is some version of "ensure skilled care for every birth"[3]—that is, to increase the proportion of deliveries attended by "skilled birth attendants" (SBAs). Ministries of Health have heard this message loud and clear and are acting upon it, largely to the exclusion of serious attention to the actual care being delivered—even if this was not the intent of global technical leaders promoting Skilled Birth Attendance.

There are important problems both with the particulars of a strategy centered too exclusively on SBA coverage and with the notion that any single service delivery approach will be optimal for all settings. In its effect, the current approach as actually delivered could be characterized as: "Get them in the front door and then trust the clinician."

Since around 2000, the ***newborn health*** community rapidly established a presence, largely due to the

The Problem and the Needed Remedy		
Grand (content-free, one-size-fits-all) Strategy	→	Content-focused, context-driven solutions
Stovepipes as a barrier to care	→	Coherent, linked-up care
Distracted, poorly enabled managers	→	Informed, empowered managers

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Saving Newborn Lives program, funded by the Bill and Melinda Gates Foundation (BMGF), and to a succession of central projects funded by the U.S. Agency for International Development (USAID) that have included both maternal and newborn health. Without directly challenging the dominant maternal health Grand Strategies, the newborn field has attempted to legitimize a wider domain for action under the rubric of the ''household-to-hospital continuum of care,''[4] with enthusiastic support from at least some in the maternal health community. In practice, however, building on lessons learned from the work of Abhay Bang,[5] the newborn health community has focused primarily on *community-based* service delivery. This has required some delicacy because the maternal health field has proscribed use of traditional birth attendants (TBAs) at home deliveries. The newborn health field therefore has advocated use of *non-TBA* community health workers (CHWs) to care *only* for the newborn, either by being present for home deliveries or by coming to the home soon after delivery.

Contact-Centered

As it plays out at the level of actual service provision, the emphasis in the maternal health field has been on mere *contact*—that is, it has focused on having women deliver in the presence of a skilled birth attendant, simply assuming that the ''skilled'' provider will do all that is required. This situation has arisen in part due to the almost exclusive reliance on the SBA indicator as the principal proxy measure (or global benchmark indicator) for maternal health program performance, despite abundant evidence that, in many instances, those labeled as ''skilled'' providers do not have the appropriate skills[6] and that—whether skilled or not—they often do not do the right things.[7] So, not surprisingly, we see little, if any, correlation between ''skilled birth attendance'' and overall maternal or newborn mortality.[8–11]

With its almost exclusive focus on labor and delivery, the current approach as implemented has largely ignored opportunities to achieve better outcomes arising during pregnancy (only paying attention to whether the requisite antenatal *contacts* occur).

Like the prevailing maternal health Grand Strategy, the ''postnatal home visits'' strategy now being promoted in newborn health[12] also emphasizes *contact*, assumes that such contact will deliver impact, and gives comparatively little attention to the *content* provided. With an evidence base consisting only of relatively small-scale, intensively supported trials[13–14] and demonstration projects,[5,15] the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) have advised Ministries of Health to develop national programs with CHWs making multiple postnatal home visits.[12] Many countries have launched such programs; however, to date, there has been no evidence that it is feasible to achieve impact at scale with this approach.

Although global health leaders have increased attention to defining priority content of care in recent years,[16] there has been little *effective* programmatic attention to content. In maternal health, any attention to content has focused largely on labor and delivery care, notably on management of a particular set of complications (the emergency obstetrical care ''signal functions''),[17] with a nod to ''focused antenatal care.''[18] Under USAID-funded work, there has been some effort given to uterotonic use to prevent postpartum hemorrhage and to ''keeping the normal normal.''[19]

Newborn health proponents also have limited their focus largely to the delivery and the early postnatal period, paying particular attention to: kangaroo mother care for low birth weight babies, resuscitation of asphyxiated newborns, community case management of sepsis, and a wider set of clinical and household practices encompassed by the term ''essential newborn care.'' This has recently expanded somewhat, with more attention now to the use of corticosteroids for threatened preterm labor and a new focus on stillbirths and ''intrapartum'' (rather than ''asphyxia'') deaths. This reframing draws attention to the important opportunities available to influence these outcomes, not only by resuscitating newborns *in extremis* (at the point of death) but also by providing better care *before* they get to that state (either spontaneously or iatrogenically).

Increasing the proportion of deliveries in the presence of ''skilled birth attendants'' does not necessarily reduce maternal or newborn mortality.

Both maternal and newborn health fields still remain quite focused on the ''supply side,'' with less programmatic attention given to care-seeking and household practices.

Global maternal and newborn health guidance has focused largely on the supply side to the neglect of care-seeking and household practices.

Uncontextualized Directives on ''How''

So, both the SBA and Postnatal Home Visit strategies have focused mainly on *contact*, either with a health worker of a certain occupational

category at the time of delivery or with a community health worker during a postnatal home visit. In both cases, we have prescriptive strategies that *all* are enjoined to adopt, focusing on *how* services are provided (that is, that there be a contact of a certain kind). This is quite different from providing guidance on *what* specific technical content should be delivered (Box 1).

It is true that, since epidemiology differs by setting, there does need to be some adaptation or prioritization of the ''what'' (the technical content) by setting. Nonetheless, the ''what'' generalizes fairly broadly across settings. This is less so for the ''how.'' We cannot simply say, ''This is an effective strategy. Everyone should be doing it, everywhere.'' Randomized trials such as those referenced above[13,14] do not help us much here, as we are less interested in the black-and-white question of ''Does it work?'' than we are in the questions, ''*Under what conditions* does it work?'' and ''Could this be both effective and *implementable at scale in my setting*?''

How best to implement effective maternal and newborn health strategies requires attention to local context.

Although mother and the fetus/newborn are inextricably linked to each other, global strategies and funding for maternal health and newborn health have separated them.

Box 1: ''How'' Versus ''What''

How

- Tiered complication management services (basic and comprehensive emergency obstetrical care)
- Deliveries by health care workers with midwifery skills
- Community midwives
- Deliveries assisted by traditional birth attendants
- Postnatal home visits by community health workers
- Antenatal risk stratification, with referral of higher risk cases

What

- Uterotonics during the third stage of labor
- Corticosteroids for preterm labor
- Antibiotics for sepsis
- Magnesium sulfate for eclampsia
- Chlorhexidine for newborn sepsis prevention
- Resuscitation of asphyxiated newborns
- Intermittent presumptive treatment for malaria
- Early and exclusive breastfeeding
- Tetanus toxoid

Conditions vary enormously across (and often within) countries with high maternal and newborn mortality and stillborns. For example, in some countries certain ''indirect causes'' (such as malaria) are major contributors to poor pregnancy outcomes. Use of specific dangerous practices—whether by TBAs or professional attendants—varies considerably. Access to health facilities and professionals varies greatly due to geography, population density, and availability of human resources (and barriers related to such factors as cost and culture). Settings differ considerably in the robustness of basic support systems (for example, infrastructure and commodity supply chains). So, the strategies likely to be most effective will be those that fit the specific characteristics, drivers, opportunities, and constraints for maternal and newborn health *as they play out locally*.

Stovepipes as a Barrier to Care

The Maternal-Newborn Split

To a considerable extent, global technical strategies for maternal and newborn health have moved independently of each other. This defies biology: Until birth, mother and fetus are unequivocally an inseparable dyad, with the well-being of the fetus/newborn fundamentally dependent on whatever happens to the mother. To a large degree, this continues through early newborn life. Furthermore, the opportunities to optimize maternal, fetal, and newborn outcomes arise from much the *same* contacts—through health workers or CHWs during pregnancy, at the time of labor and delivery, and during the postnatal period, either at a health facility or in the home.

The conventional clinical division of labor between obstetricians and pediatricians/neonatologists often carries over into maternal-newborn program work (although in many service delivery settings a single provider is responsible for care of both the mother and newborn). Technical leaders in maternal and newborn health sometimes convene and cooperate, but much of the time they spin in their own separate orbits (for example, in their own global plans and strategies, publications, global and national

working groups, technical meetings, and conferences).

Donor funding for maternal and newborn health also tends to be siloed in separate funding streams. USAID has bucked this trend to some extent, by combining maternal and newborn health in its central projects (such as the Maternal and Neonatal Health [MNH] program, ACCESS program, and the Maternal, Neonatal and Child Health Integrated Program [MCHIP]). However, despite this management arrangement, *even within these projects* maternal and newborn health still mostly move along independent tracks. In its global projects, BMGF continues to support maternal and newborn work under entirely separate funding mechanisms. (In their *country-level* work, USAID and BMGF do support programs that integrate maternal and newborn health.) And DfID, despite commendable support for maternal health, has to date largely ignored the newborn.

In many cases, in funding and technical agencies and in Ministries of Health, responsibility for maternal and newborn health falls under different management units or technical officers. This can ripple through inappropriately to the service provider level. One consequence of this split has been that technical leaders, in the one camp, have made strategic choices to optimize *their* outcomes of concern without reference to the other. For example, maternal health leaders have, in effect, prohibited programmatic engagement with TBAs or other community-based service providers, because they felt this was of little value for maternal health outcomes, regardless of what benefits there may be for the newborn.[20]

Fragmentation Across Programs

Beyond the maternal-newborn gap, a number of important interventions delivered during pregnancy or in the postnatal period are ''owned by'' other potentially competing programs with their own funding streams, such as:

- Antenatal and postnatal iron supplementation and breastfeeding counseling (nutrition)
- Intermittent presumptive treatment and use of insecticide-treated nets (ITNs) (malaria)
- Tetanus toxoid and hepatitis B immunization (immunization/child health)
- Counseling on postpartum family planning (family planning/reproductive health)
- Syphilis screening and treatment (sexually transmitted infections)
- HIV screening/prevention of mother-to-child transmission (PMTCT) (HIV/AIDS)

Categorical funding and other structural barriers render *antenatal* care (ANC) a kind of programmatic no-man's land, with an absentee landlord (Maternal Health, focusing only on ANC *contacts*) and orphan tenants laboring in other programs. These ''orphans'' struggle to deliver their interventions through a relatively neglected service delivery channel, or they disengage from ANC altogether and use their own channels, as is often the case with antenatal tetanus toxoid. Similarly, in the limited discussion now heard among global MNH technical leaders on action to be taken in the *postnatal* period, there has been little attention to interventions perceived as belonging to other program areas (such as malaria, immunization, HIV, and nutrition).

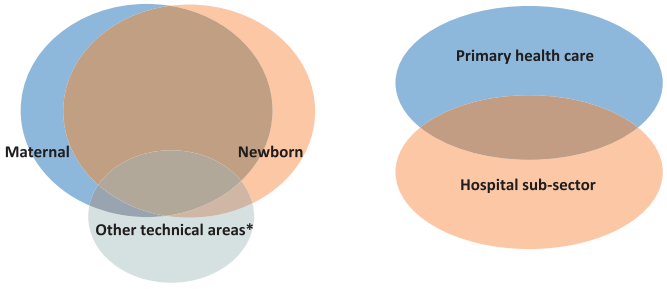
Even interventions that can have high impact on reducing mortality in certain settings are rarely championed by technical leaders in MNH, when they are seen as belonging to other programs (for example, ITNs, antenatal iron supplementation, PMTCT, and syphilis screening and treatment). The result of this stove-piping has been that women and newborns are less likely to get these needed (and generally quite simple) interventions and are therefore at higher risk of poor outcomes (see Figure).

The Hospital/Primary Health Care Sub-Sector Disconnect

Another unhelpful form of siloing has been between the hospital and primary health care sub-sectors (see Figure). Typically, hospitals are managed under altogether different units of the Ministry of Health than services up to the health center level (which include most antenatal services and, in at least some settings, a significant proportion of institutional deliveries). Sometimes they are managed under altogether different ministries! So, not surprisingly, on-the-ground coordination between these different types of health facility is generally weak, if not non-existent. This contributes to poorly developed referral linkages, with unhappy consequences for many women and newborns experiencing complications that require prompt, effective referral to higher levels of care.

Pregnancy, labor and delivery, and postnatal interventions falling under other programs (such as HIV, malaria, nutrition) tend not to be well-integrated into maternal and newborn health services.

FIGURE. Managing the Overlap: Maternal and Newborn Health Services as an Integral Whole



* Examples of other technical areas include nutrition, malaria, and immunization, delivered through antenatal or postnatal care.

Distracted, Poorly Enabled Program Managers

As discussed above, regardless of their own judgment on what may be needed, program managers at the country level have been pressed to focus especially on: increasing institutional deliveries and, resources permitting, in-service training for health care workers providing labor and delivery care. On the newborn side, they are given a very short list of interventions and service delivery approaches to ''scale up.''

Effective maternal and newborn health strategies are appropriately tailored to the local context.

Program managers neither have been encouraged nor have been enabled to *track what is actually happening* when such services are provided—as a basis for taking action to improve effective coverage. Furthermore, responsibility for services or interventions delivered during pregnancy, around the time of delivery, and over subsequent days and weeks is distributed across multiple programs and management units. The result is that no single manager or program is empowered or held accountable to ensure the reliable delivery of the full range of important services at high coverage.

WHAT IS NEEDED?

Context-Driven, Content-Focused Solutions

At the global level, we must be careful to avoid being inappropriately prescriptive on service delivery approaches (Grand Strategies). Although those at the global level may not have perceived their guidance in this light, too often this has been its effect at the country level.

Country-level program managers need to be encouraged and supported to determine the most promising strategies for achieving impact *in their settings* by looking at the particular situations they face, including local epidemiology and population distribution, service utilization patterns, barriers to access, availability of resources, and robustness of support systems. Often they can draw useful lessons, or adopt and adapt tools or models, from experience elsewhere, particularly if conditions in those other settings are comparable to their own. But, at the end of the day, program managers will need strategies that fit their own particular circumstances. Strategies, grand or otherwise, are a problem if they are not a good fit with the setting in which they are introduced. We cannot assume fit; we must verify it.

Rather than being told to all use the same service delivery strategies, program managers need to be encouraged and empowered to determine the most appropriate approaches beginning from where they are.[20] What opportunities are currently available? For example, if the goal is improved delivery of key postnatal interventions and a relatively high proportion of deliveries in a particular setting currently occur in health facilities, by all means program managers should take advantage of hospital admissions as a platform for providing such interventions (for example, focusing on pre-discharge assessment, counseling about danger signs and essential newborn-care practices, providing hepatitis B immunization, dispensing

iron supplements or any other needed supplies). Why ignore this opportunity and, instead, focus efforts on trying to develop a new platform of postnatal home visits by CHWs (particularly when there have been no successful experiences elsewhere implementing such a strategy at scale)?

The whole span of maternal and newborn services comprises a fairly wide range of interventions, delivered over several stages of the life cycle—some on a schedulable basis, some not. Some of this content is simple enough to be delivered by health auxiliaries or CHWs. But other aspects of care require complex skills and support services. Conditions relevant for using a particular strategy vary a great deal by setting. In all these respects, maternal and newborn health is inherently more complex than immunization, for example. We should not be surprised, then, that a greater degree of tailoring to context is needed to effectively deliver maternal and newborn health services to a population.

Our emphasis to date on ''skilled birth attendance'' has resulted in misdirected program effort. *Where* services are delivered, or *by whom*, do not by themselves drive outcomes. *What is actually done* drives outcomes. The message to country programs needs to change from a focus on *contact* toward *content*—that is, toward the *substance* of care actually delivered. Our focus needs to be on delivery of that substance to all those needing it; ''contact'' is important only as a means to that end.

In addition to focusing on the specific *positive* practices we want to see, we also need to eliminate common *negative* practices that increase risk of poor outcomes (such as poor asepsis, unsafe labor augmentation, application of fundal pressure, and medically unnecessary procedures with inherent risk, notably elective cesarean delivery).

Coherent, Linked-Up Care

Pregnant women, newborns, and postpartum mothers require a set of services provided coherently and comprising all needed elements, regardless how the ''ownership'' of those elements is distributed across programs. It may be unrealistic to tear down all structural, disciplinary, and financial silos, although donors do have scope to combine funding streams and management units. Nevertheless, to the extent that we have to continue to live with such barriers, we need to find ways to mitigate their counterproductive effects on service delivery as experienced by actual beneficiaries.

Where possible, maternal and newborn management units, technical coordination bodies, and funding streams should be merged, and serious efforts made to ensure effectiveness and coherent delivery of the full package of needed interventions, including those currently ''belonging'' to other programs. As a maternal or newborn health program manager considering, for example, use of bed nets by pregnant women, mothers, and newborns living in malarious areas, it is not good enough to say: ''Oh, the malaria people will take care of that with their funds and monitoring systems; that's not our responsibility.'' Donors and technical assistance partners need to be part of the solution rather than reinforcing the walls of their silos.

An often-used buzz word in global health today is ''integration.'' The services that need to be delivered during pregnancy, childbirth, and the postnatal period are crying out for more coherent, integrated effort cutting across current programs and categorical funding streams.

Informed and Empowered Managers

We can almost never count on our initial plans getting everything right (recalling that ''no battle plan survives contact with the enemy''). But once we have begun to implement a plan, if we closely *monitor what is happening practically*—in real time—we can see how our programs or services are actually performing and then, based on this information, take any required action to bring about better performance.

Emphasis should be placed on the *actual substance of care* delivered, not on *where* or *by whom* the care is delivered.

Managers at national and local levels need to be able to track what is actually happening with maternal and newborn services and programs, beyond mere inputs. Although it is generally not possible to track population health status closely, program managers need some reasonable approximation. What is happening with regard to *effective coverage*—in other words, what proportion of all of those in a population requiring a particular service are actually getting it (delivered in a way that its effectiveness is assured)?

Practical monitoring data directs managers on the actions necessary to improve program performance.

Program managers also need to be able to track *key determinants* or drivers of effective coverage (sometimes described as ''implementation strength''[22]). For example, if the intervention of interest is adequate case management of newborn sepsis, how is the supply chain for the needed antibiotics performing? What are the stockout rates?

Programs in immunization and tuberculosis have been well-served by a small set of meaningful *program indicators* (for coverage and commodity logistics), tracked regularly through health management information systems, which are actively used as a basis for effective decision-making to address compromised performance. Despite all the measurement work that has been done in maternal and newborn health, effort has largely focused on surveys and special studies, generally conducted as one-offs or—at best—once every 5 years. Such surveys do not meet the need of program managers for ongoing, real-time tracking and management of program performance.

At the health facility level, some efforts *have* been made to implement quality improvement processes or approaches (including use of partographs or checklists, Improvement Collaboratives, Standards-Based Management and Recognition, criterion-based audit, and maternal and perinatal death audits), but these initiatives generally have been too intensive and dependent on external inputs to be implemented effectively at scale on a sustained basis. There have also been efforts by WHO and others to identify a limited number of maternal and newborn content/quality indicators that could be incorporated into routine health management information systems for monitoring at all levels, but this has yet to gather steam (Box 2).

What is needed for maternal-newborn health programs to deliver impact at population scale is a clear shift from just ''trusting the clinician'' toward *effective monitoring* and *active management* of key aspects of service delivery and program performance at all levels—from the health facility through the Ministry of Health. We need to empower managers, giving them a window on what is actually happening in the services for which they are responsible, as a basis for actively managing them to improve coverage and quality and reduce preventable deaths. And program managers responsible for maternal and newborn health services need to be mandated and held accountable for delivery of all high-impact elements of care at this stage of the lifecycle, including those now falling under the responsibility of other programs.

Our global health community has committed itself to ending preventable child and maternal deaths. Perhaps more than ever, there is a sense of urgency and hope that we really can do something about this continuing tragedy. The key challenge is effective implementation in the real world—no easy task. We need, now, to make sound choices to make that happen.

Box 2: Possible Routine Monitoring Indicators

- Use of a uterotonic during the third stage of labor, as a percentage of term deliveries
- Intrapartum stillbirths and very early neonatal deaths, as a percentage of term deliveries
- Of all maternal and perinatal deaths, percentage followed up by an audit
- Of health facilities routinely doing deliveries, percentage that have institutionalized death audits for all maternal and perinatal deaths
- Stockout status (for example, any stockout over the previous 3 months) for key program commodities in labor and delivery areas of health facilities (oxytocin, magnesium sulfate, gentamicin, dexamethasone)
- Cesarean deliveries, as a percentage of term deliveries
- Assisted vaginal deliveries, as a percentage of term deliveries
- Of health facilities routinely doing deliveries, percentage in compliance with the baby-friendly hospital initiative

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The issues discussed in this commentary are dealt with in considerably more detail in a white paper, available at http://www.healthynewbornnetwork.org/sites/default/files/resources/MNH%20white%20paper%20extended.doc.

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COMMENTARY

Multiplicity in public health supply systems: a learning agenda

Alan Bornbusch,[a] James Bates[b]

Supply chain integration—merging products for health programs into a single supply chain—tends to be the dominant model in health sector reform. However, multiplicity in a supply system may be justified as a risk management strategy that can better ensure product availability, advance specific health program objectives, and increase efficiency.

Conventional wisdom in health sector reform tends to favor **supply chain integration**—merging supply chain functionalities, such as distribution, across different health programs—to improve efficiency and health systems overall. Supply chain research and application in the commercial sector, however, point toward **multiplicity in supply systems**—that is, structuring a supply system to take advantage of multiple supply chains or supply chain segments to reduce risk and maintain supply.

We explore the role that multiplicity has played historically in public health supply systems and consider recent examples where multiplicity has been introduced to reduce risk and improve system performance. The limited, but suggestive, evidence from public health supply systems thus far, combined with recent methodological advances, point to the need and opportunity for further inquiry into the case for multiplicity in public health supply systems in low- and middle-income countries.

THE CENTRAL MEDICAL STORE MODEL

In Africa, Asia, and Latin America, the **"central medical store" (CMS) supply chain model** dominates in public-sector health programs—a model that is both administratively and physically centralized. Procurement typically takes place at the national level; most stock enters distribution through a centrally located warehouse in the capital city; and a public-sector entity implements (or at least oversees) distribution.

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CMSs have long been perceived to be burdened with the inefficiencies and shortcomings widely associated with monopolistic systems, and sometimes are even described as "monopolies." The term is not inappropriate. In most cases, CMSs have handled a predominate share of supplies distributed within the public sector. More importantly, their roles have often been protected by law, and they usually have not been threatened with losing their business to more efficient systems.[1–5]

THE ALTERNATIVE MODEL OF MULTIPLICITY

Rarely, however, are CMSs true monopolies, as they almost always operate in the company of other supply chains. A hybrid state often prevails, more appropriately characterized as a supply network or system.

Indeed, ministries and donors have introduced alternative supply chains or supply chain segments since the earliest days of development assistance, including:

- Donor-managed procurement and distribution to countries
- Nongovernmental organizations (NGOs) taking on procurement and distribution responsibilities
- "Vertical" supply chains serving the distribution needs of specific health programs
- Country governments purchasing services from private logistics providers on a routine basis

Considering this history, **3 principal motives** emerge for moving outside routine CMS operations and toward multiplicity:

1. Situation-specific problem solving
2. Advancement of priority health program objectives

3. Pursuit of efficiency through options-building

We explore these motives further in the **3 mini-case studies** that follow. All 3 motives represent forms of risk management,* whether it be managing the risk of non-availability of essential products; inability to provide priority health services; or higher than necessary acquisition and operating costs.

Many of these risks and the approaches taken to manage them resemble those studied in supply chain research and applied in commercial sector practice. Indeed, multiplicity, including managing multiple supplier pipelines or segmenting supply chains, is an established risk management approach in commercial supply systems.[7–10] (Supply chain segmentation is one way to organize a supply system into specialized supply chains or supply chain segments that are tailored to groups of products that share certain characteristics, such as demand patterns.[11–13])

Uganda: Situational Problem Solving

Situation-specific problem solving in supply chain management can be thought of as activities (for example, procurement, storage, and transport) that are deployed in an ad hoc manner to respond to events, such as disease outbreaks, natural disasters, or management of a donor-required competitive bidding process. Ad hoc solutions are also sometimes needed to address more general supply chain breakdowns that threaten supply shortages. The solution to an immediate problem can prove valuable in more than just the short term, revealing opportunities for overall improvement in a supply system. A case in point comes from Uganda.

In early 2010, demand for family planning supplies managed by the public sector's National Medical Stores (NMSs) rapidly increased. Simultaneously, policy changes and a significant gap in funding for commodities made it more difficult for NGOs and faith-based organizations (FBOs) to obtain supplies from the public sector. This led to widespread contraceptive stockouts at private-sector community-based facilities.

In response, a new supply chain was created, managed by a local social marketing organization. Members of the Uganda Family Planning Coalition, formed by Uganda's leading family planning providers in response to the crisis, were the first to receive supplies through this channel. The channel has since grown into a supply chain used by the government and donors to deliver reproductive health commodities to NGOs, FBOs, and small for-profit providers (with an expected value of US$20 million for 2013–2014). The creation of a supply chain to serve private-sector providers alongside the NMS-managed system marks an important step forward in increasing access to contraceptives in Uganda (personal communication with Linda Cahaelen, Senior Technical Advisor, USAID, 2012).

3 key advantages of multiplicity in supply chains: ensuring product availability, advancing priority health objectives, and greater efficiency.

Bangladesh: Advancing Priority Program Objectives

In some places, donor and country partners set up program-specific supply chains that operate alongside the CMS system to advance certain priority health program objectives. Family planning, immunization, malaria, and tuberculosis are among the best known. These so-called vertical supply chains are often judged in health reform circles as inefficient and counterproductive in strengthening a more integrated CMS. In most cases, their good track record suggests a more complicated picture.

Although concern about financial sustainability is valid, critics of vertical supply chains tend to overlook the health program growth and public health impacts of these systems. Consider Bangladesh, where use of modern contraception has grown nearly 10-fold from 1975 to the present. Investments in supply chains dedicated largely to family planning products in the public and private (social marketing) sectors are widely credited to the phenomenal success of family planning programs in Bangladesh.[14–15] Indeed, several multiplicities have operated:

- Within the public sector, two separate supply chains, with similar functional capabilities but applied to different products, operate—one mostly for family planning products and the second for other essential medicines.
- The public sector and social marketing supply chains for family planning have at times functioned as if parts of a coordinated system, exchanging products when one or the other experiences shortages.

Supply chain investments for contraceptives have contributed to the success of the Bangladesh family planning program.

* Risk management in the supply chain context is the implementation of strategies (of which multiplicity is one) to manage risks along the supply chain (such as a procurement delay, a distributor going out of business, or security threats) based on continuous assessment and with the objective of reducing vulnerability and ensuring continuity of supply to the end customer.[6]

- The public sector has employed multiple distribution options, contracting with commercial carriers to cover parts of the country.

By ensuring a reliable supply of contraceptive products, these supply chains have helped to engender a public expectation of and demand for widespread family planning services—an important ingredient to the long-term sustainability of family planning in Bangladesh.

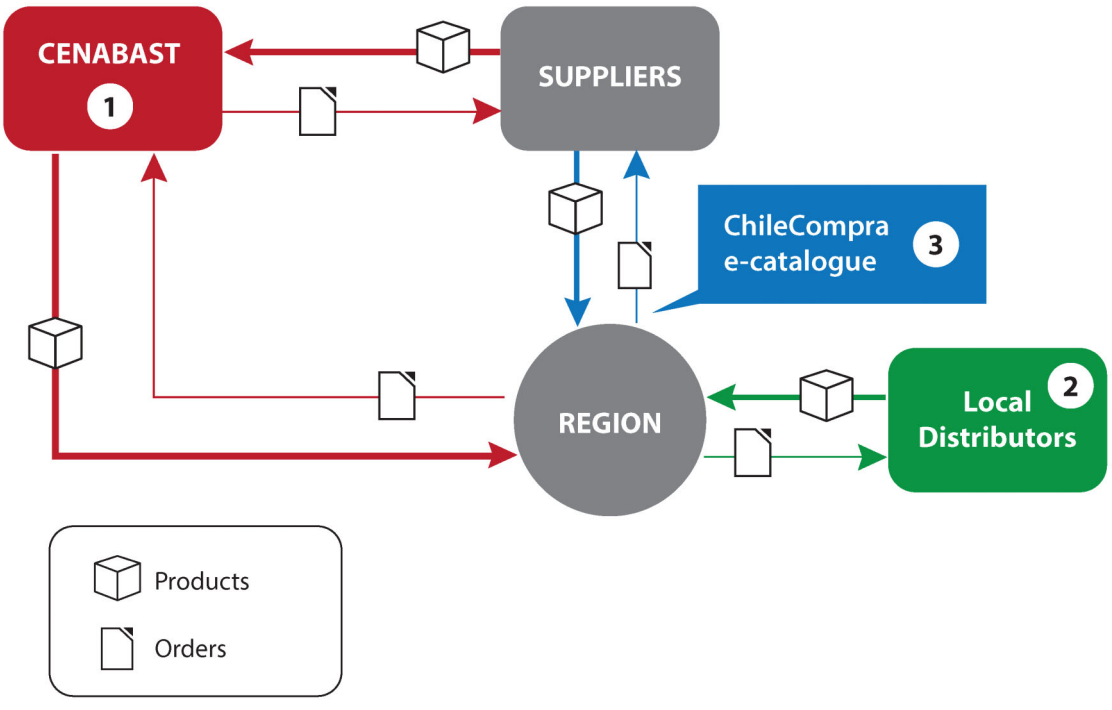
Chile: Building Options

Between 1970 and 2010, the CMS in Chile known as CENABAST (Central de Abastecimiento) provided procurement and distribution services for all essential health commodities to 26 regional health authorities.[16] In the early 2000s, Chile decentralized its health management system. The government gave regional health offices latitude to purchase through CENABAST or from local distributors. Overall, CENABAST did not suffer from dysfunction during this period, and most regional health offices continued to use CENABAST despite having other options.[17]

In addition to using CENABAST, in 2010 regional health offices also began purchasing commodities through ChileCompra (''Chile Buys''), a government-wide e-procurement service.[18] ChileCompra negotiates multi-year agreements with suppliers for products that, for example, have high volume and predictable demand. Using an electronic catalogue, government agencies can take advantage of the lower prices negotiated by ChileCompra and avoid the expense and delays of issuing individual tenders.[19]

In Chile, the Ministry of Health had not set out to purposely build multiplicity (see Figure). Rather, other developments, such as

FIGURE. A Supply System With Multiplicity



Regional health authorities in Chile have several options to procure health commodities: (1) from CENABAST (the central medical store), who in turn procures from suppliers (red lines); (2) from local distributors (green); or (3) directly from suppliers through the ChileCompra e-catalogue, using pre-established agreements (blue). The Ministry of Health has overall oversight for the system.

decentralization, procurement reform, and segmentation of procurement between CENABAST and ChileCompra for greater efficiency, have promoted this result.

A LEARNING AGENDA

Is there a downside to multiplicity in supply systems? There can be. For example, multiplicity has in all likelihood been carried to excess where there is an over-proliferation of program- or donor-specific supply chains.[20–22]

Advantages of multiplicity include:

- Greater flexibility to maintain supply
- Competition can lower costs and improve service levels
- Supply chains or segments can be tailored to program- or product-specific needs

Disadvantages include:

- Need for increased oversight, management, and coordination across the supply system
- Increased cost and potential for inefficiency
- Over-specialization can reduce flexibility

Although these pros and cons are to a certain degree intuitive, public health supply systems in low- and middle-income countries have had difficulty in conducting more rigorous analysis of multiplicity. Data and methodological constraints have prevailed, even for the 3 examples that we cite. But these constraints are changing, pointing to a learning agenda that can be pursued more productively now.

The challenge is to identify a state of *prudent* multiplicity where the costs of additional supply chains (as in Uganda for different sectors or in Bangladesh for different programs) or supply chain segments (as in Chile for procurement) are justified by better risk management, improved supply chain performance, and improved health outcomes. Regarding the universe (or multiplicity) of supply chains in a country as an overarching system provides a constructive framework. Agile use of supply chain resources (for procurement, warehousing, transport, and so forth), wherever they are found and capable to the task, is key to reducing risk and improving performance.

How to find that ''sweet spot?'' Methods to measure the performance of public health supply systems are well established, and costing methods in the data-poor environments of low- and middle-income countries have recently begun to emerge.[23–25] Likewise, evaluation and modeling of risk in these supply systems is growing.[26] And methodologies now exist to link supply system performance to health outcomes, at least in the family planning field[27–28]—particularly important when considering the economic savings from improved health outcomes enabled by greater availability of commodities to patients, which may outweigh any increased costs associated with multiple supply systems.

By this confluence, a more structured, holistic approach to assessing, designing, and testing multiplicity is within reach. We suggest 2 avenues:

1. **Retrospective studies** of multiple supply systems may be possible in more data-rich environments.
2. **Intervention research** is also needed to test how multiplicity can be purposely built into public health supply systems to optimize across cost, risk management, and performance. An example of this kind of intervention research is a pilot project in Zambia that evaluated the effectiveness of different approaches for delivering essential medicines.[29]

Methodological advances now support a more rigorous assessment of the role that multiplicity can play in public health supply systems.

A greater analytical understanding of the role of multiplicity in public health systems is critical in preparing the systems of the future to handle the growing numbers and volumes of commodities to meet customers' needs.[30–31] As with any significant health system transformation, increased acceptance of multiplicity requires more than just rigorous data and evaluation, and includes advocacy, political support, and leadership to overcome entrenched interests. But the case will best begin with the analytics.

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TECHNICAL CONCEPT

mHealth innovations as health system strengthening tools: 12 common applications and a visual framework

Alain B Labrique,[a] Lavanya Vasudevan,[a] Erica Kochi,[b] Robert Fabricant,[c] Garrett Mehl[d]

This new framework lays out 12 common mHealth applications used as health systems strengthening innovations across the reproductive health continuum.

The rapid proliferation of mHealth projects—albeit mainly pilot efforts—has generated considerable enthusiasm among governments, donors, and implementers of health programs.[1] In many instances, these pilot projects have demonstrated conceptually how mHealth can alleviate specific health system constraints that hinder effective coverage of health interventions.

Large-scale implementation or integration of these mHealth innovations into health programs has been limited, however, by a shortage of empirical evidence supporting their value in terms of cost, performance, and health outcomes.[1–4] Governments in low- and middle-income countries face numerous challenges and competing priorities, impeding their ability to adopt innovations.[2] Thus, they need robust, credible evidence about mHealth projects in order to consider mHealth alongside essential health interventions, and guidance about which mHealth solutions they should consider to achieve broader health system goals.[2] Their tolerance for system instability or failure can be low, even when the status quo may be equally, or more, unreliable.

Current larger-scale effectiveness and implementation research initiatives are working to address the evidence gaps and to demonstrate the impact of mHealth investments on health system targets.[1] Other efforts are underway to synthesize such findings.[5]

MHEALTH AS A HEALTH SYSTEMS STRENGTHENING TOOL

Recent mHealth reviews have proposed that innovators focus on the public health principles underlying mHealth initiatives, rather than on specific mHealth technologies.[6] International agencies and research organizations have also endeavored to frame mHealth interventions within the broader context of health system goals or health outcomes.[2] The term "health system" includes all activities in which the primary purpose is to promote, restore, or maintain health.[7] Some elements of a framework for evaluating health systems performance by relating the goals of the health system to its essential functions have been proposed previously, which we believe can serve as a model for articulating and justifying mHealth initiatives and investments.[7]

Applying a health systems lens to the evaluation of mHealth initiatives requires different indicators and methodologies, shifting the assessment from whether the mHealth initiative "works" to process evaluation or proxy indicators of the health outcome(s) of interest. This new way of thinking would facilitate selection of mHealth tools that are appropriate for identified challenges. In other words, it would drive people to first identify the key obstacles, or constraints, to delivering proven health interventions effectively, and to then apply appropriate mHealth strategies that could overcome these health system constraints.[8]

Presenting mHealth as a range of tools for overcoming known health system constraints, as a health systems "catalyst," may also improve communication between mHealth innovators and health program implementers. Communicating mHealth technologies as tools that can enhance delivery of life-saving interventions through improvements in health systems performance, such as coverage, quality, equity, or efficiency, will resonate with health decision-makers.[7]

Hence, rather than being perceived as siloed, stand-alone solutions, mHealth strategies should be viewed as integrable systems that should fit into existing health system functions and complement the health

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system goals of: health service provision; a well-performing health workforce; a functioning health information system; cost-effective use of medical products, vaccines, and technologies; and accountability and governance.[9]

A SHARED FRAMEWORK TO EXPLAIN MHEALTH INNOVATIONS

The absence of a shared language and approach to describe mHealth interventions will continue to hinder efforts to identify, catalog, and synthesize evidence across this complex landscape. The lack of a common framework also makes it hard to explain mHealth innovations to mainstream health-sector stakeholders.

mHealth researchers and implementers at the World Health Organization (WHO), the Johns Hopkins University Global mHealth Initiative, the United Nations Children's Fund (UNICEF), and frog Design have jointly developed the ''mHealth and ICT Framework'' to describe mHealth innovations in the reproductive, maternal, newborn, and child health (RMNCH) field, in which mobile health technologies have been broadly implemented over the last decade across the developing world.

The framework builds on prior efforts to describe types and uses of mHealth generally, such as in the WHO global survey on eHealth[2] and in the mHealth Alliance's typology for mHealth services in the maternal and newborn health field.[10] These previous efforts, however, have focused more explicitly on the type of actor (client, provider, or health system) and location of the mHealth activity (community, facility, or health information system). Some of these descriptions provide details about the use of specific mobile functions (such as toll-free help lines) to accomplish particular health goals, although other functions could have been used to accomplish the same goals and, over time, the functions described could be superseded by newer technologies. Furthermore, their classification approaches have not provided stakeholders with the tools to enable them to understand the diverse ways in which specific mobile functions could be employed for a particular health purpose.

Our framework is constructed around standard health system goals and places intended users and beneficiaries in central focus, against the context of the proposed mHealth service package (Figure 1). By describing a specific mHealth strategy or approach, the framework visually depicts the when, for whom, what is being done to alleviate which constraints, and the how of the strategy. The framework comprises 2 key components:

1. A place to depict the specifics of the mHealth intervention, described as one or more common mHealth or information and communications technology (ICT) applications used to target specific health system challenges or constraints within specific areas of the RMNCH continuum of care (Figure 1, upper section).
2. A visual depiction of mHealth implementation through the concept of ''touch points,'' or points of contact, which describe the specific mHealth interactions across health system actors (for example, clients, providers), locations (such as clinics or hospitals), and timings of interactions and data exchange (Figure 1, lower section).

mHealth should be integrated into existing health system functions, rather than as stand-alone solutions.

12 COMMON MHEALTH AND ICT APPLICATIONS

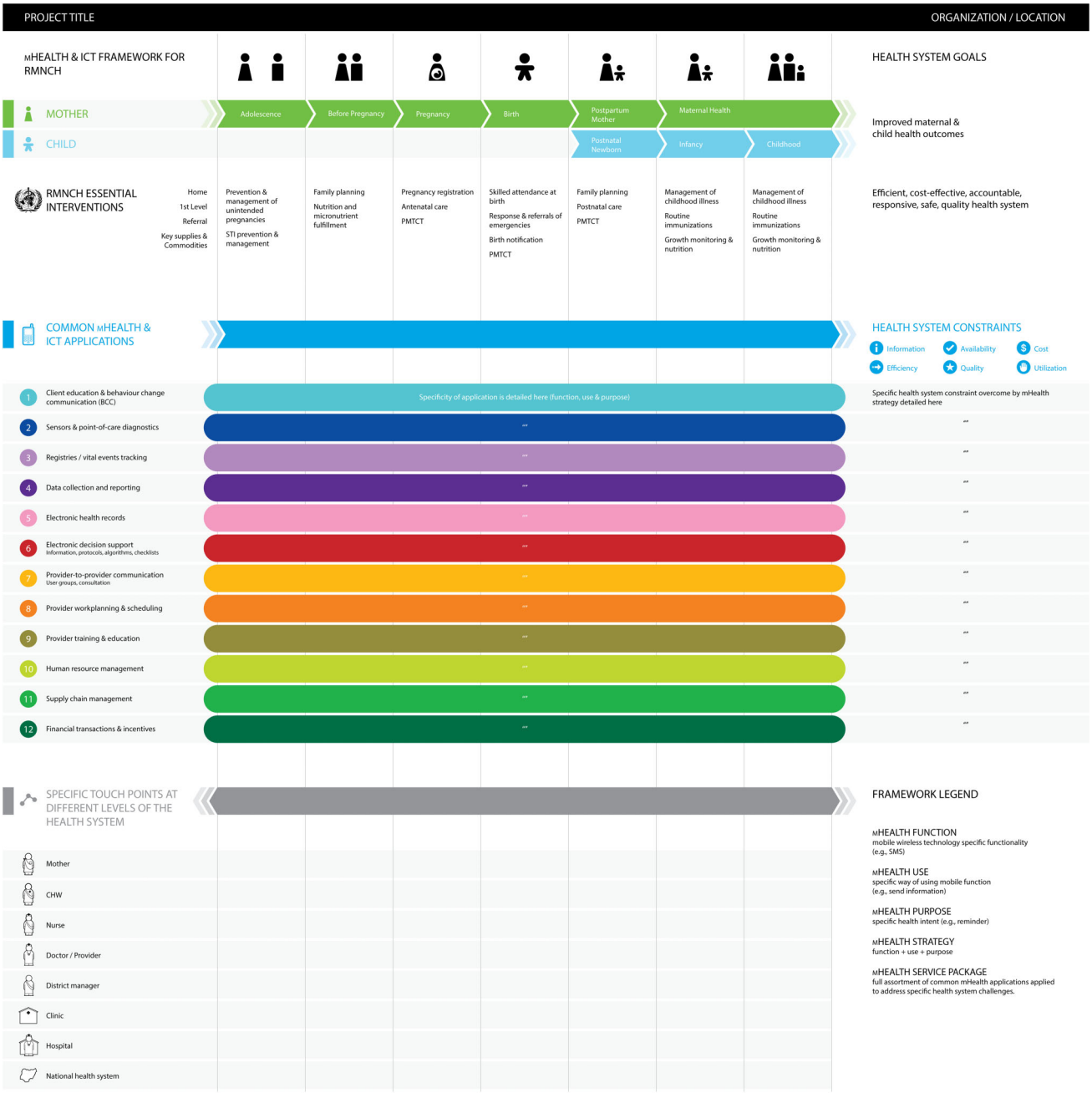
The first part of the framework aims to address a previously identified challenge in mHealth: to systematically describe the constituent parts of an mHealth strategy or platform.[11] To do this, we define relationships between common applications of mHealth and ICT and the health systems constraints that they address.[2,12–13]

Our list of 12 common mHealth applications has been vetted, through multiple iterations, by a wide group of mHealth stakeholders and thought leaders, ranging from academic researchers to program and policy implementers. Although a few mHealth projects deploy a single application, most comprise a package of 2 or more applications (Figure 2). In addition, mHealth projects employ 1 or more mobile phone functions—such as short message service (SMS), interactive voice response (IVR)—to accomplish the common applications (Table 1).

1. Client Education and Behavior Change Communication

This series of mHealth strategies focuses largely on the client, offering a novel channel to deliver content intended to improve people's knowledge, modify their attitudes, and change their behavior. Targeted, timely health education and actionable health information—delivered through SMS, IVR, audio, and/or videos that

FIGURE 1. The mHealth and ICT Framework for RMNCH



Abbreviations: CHW, community health worker; ICT, information and communications technology; PMTCT, prevention of mother-to-child transmission of HIV; RMNCH, reproductive, maternal, newborn, and child health.

FIGURE 2. Twelve Common mHealth and ICT Applications

engage 1 or more actors (such as a pregnant woman, a husband, family, community)—influences health behaviors, such as adherence to medication or use of health services.[3,14] The Mobile Alliance for Maternal Action (MAMA) is an example of an mHealth service package that provides gestational age-appropriate health information to pregnant women and new mothers on their family's mobile phone.[15]

Most mHealth interventions in this category capitalize on people's ubiquitous access to mobile phones to increase their exposure to, and reinforce, health messages. In some instances, these types of interventions also enable clients to seek more information based on their interest in a particular message—for example, through a higher level of engagement with a call-center counselor.[4]

Other mHealth interventions use mobile functions such as voice, video or audio clips, and images to enhance the effectiveness of in-person counseling, which is of particular value among low-literacy populations. Such examples include the BBC World Trust Mobile Kunji project[16] and Dimagi's CommCare Health Worker systems.[17–18]

2. Sensors and Point-of-Care Diagnostics

Harnessing the inherent computing power of mobile phones or linking mobile phones to a connected, but independent, external device can facilitate remote monitoring of clients, extending the reach of health facilities into the community and into clients' homes. Novel sensors and technologies are being developed to conduct, store, transmit, and evaluate diagnostic tests through mobile phones, from relatively simple tests, such as blood glucose measurements for diabetes management, to sophisticated assays, such as electrocardiograms (ECGs), in situations where the patient and provider are far removed from one another. These technologies also can store frequent longitudinal measures for later review during a patient-provider visit and monitor a patient's vital signs continuously and automatically, triggering a response when the device detects anomalous signals. Examples of such mHealth initiatives include the ''ubiquitous health care'' service in South Korea[19] that uses sensor technology to monitor patient health remotely and AliveCor,[20] a clinical grade, 2-lead ECG running on a mobile phone, recently approved by the U.S. Food and Drug Administration (FDA), that allows physicians to view and assess cardiac health at the point-of-care. These kinds of interventions are increasingly common in high-income settings but are less common in resource-limited contexts.

New tests are being developed and evaluated to allow diagnostics to be conducted through mobile phones, from simple blood glucose tests to sophisticated electrocardiograms.

3. Registries and Vital Events Tracking

Mobile phone-based registration systems facilitate the identification and enumeration of eligible clients for specific services, not only to increase accountability of programs for providing complete and timely care but also to understand and overcome disparities in health outcomes.[21] These are most often used for registering pregnancy and birth but also can be used for

TABLE 1. Examples of Mobile Phone Functions Used in Common mHealth and ICT Applications

	Common mHealth and ICT Applications	Examples of Mobile Phone Functions
1	Client education and behavior change communication (BCC)	• Short Message Service (SMS) • Multimedia Messaging Service (MMS) • Interactive Voice Response (IVR) • Voice communication/Audio clips • Video clips • Images
2	Sensors and point-of-care diagnostics	• Mobile phone camera • Tethered accessory sensors, devices • Built-in accelerometer
3	Registries and vital events tracking	• Short Message Service (SMS) • Voice communication • Digital forms
4	Data collection and reporting	• Short Message Service (SMS) • Digital forms • Voice communication
5	Electronic health records	• Digital forms • Mobile web (WAP/GPRS)
6	Electronic decision support (information, protocols, algorithms, checklists)	• Mobile web (WAP/GPRS) • Stored information ''apps'' • Interactive Voice Response (IVR)
7	Provider-to-provider communication (user groups, consultation)	• Short Message Service (SMS) • Multimedia Messaging Service (MMS) • Mobile phone camera
8	Provider work planning and scheduling	• Interactive electronic client lists • Short Message Service (SMS) alerts • Mobile phone calendar
9	Provider training and education	• Short Message Service (SMS) • Multimedia Messaging Service (MMS) • Interactive Voice Response (IVR) • Voice communication • Audio or video clips, images
10	Human resource management	• Web-based performance dashboards • Global Positioning Service (GPS) • Voice communication • Short Message Service (SMS)
11	Supply chain management	• Web-based supply dashboards • Global Positioning Service (GPS) • Digital forms • Short Message Service (SMS)
12	Financial transactions and incentives	• Mobile money transfers and banking services • Transfer of airtime minutes

Abbreviations: GPRS, General Packet Radio Service; WAP, Wireless Application Protocol.

tracking individuals with specific health conditions, by age groups or other characteristics. Tracking vital events (births and deaths) supports the maintenance of population registries and determination of key development indicators, such as maternal and neonatal mortality. Such mobile registries issue and track unique identifiers and common indicators, link to electronic medical records, and enable longitudinal population information systems and health reporting.

One such registry is the Mother and Child Tracking System (MCTS) in India[22] that registers pregnant women, using customized mobile phone-based applications, to help strengthen accountability for eligible clients to receive all scheduled health services (for example, 3–4 antenatal checkups, postnatal visits, and childhood vaccinations); both frontline health workers and their clients receive SMS reminders about scheduled services. Another example is UNICEF's birth registration system in Uganda, which uses RapidSMS to maintain a central electronic database of new births, updated using information transmitted via SMS, to overcome obstacles with the previously inefficient paper-based system.[23–24]

4. Data Collection and Reporting

Among the earliest global mHealth projects were those that allowed frontline workers and health systems to move from paper-based systems of ledgers, rosters, and aggregated reports to the near-instantaneous reporting of survey or patient data. Aggregation of information can occur at the server to analyze health system or disease statistics, by time, geographic area, or worker. In addition to optimizing the primary research or program monitoring and evaluation efforts of researchers, these types of mHealth initiatives reduce the turnaround time for reporting district-, local-, state-, or national-level data, which is useful for supervisors and policy makers. Countries such as Bangladesh, Rwanda, and Uganda are developing and enforcing national health information technology policies to improve the standardization and interoperability of public health data collection systems across government agencies and nongovernmental organizations (NGOs).

Platforms commonly used to develop data collection systems include Open Data Kit (ODK) and FrontlineSMS.[25–26] The Formhub platform makes it easy for developers to use Microsoft Excel to create electronic forms, which can be deployed via Web forms or Android phones, with sophisticated server-side facilities for data aggregation, sharing, and visualization.[27] A large number of commercial systems exist for the range of mobile operating systems (iOS, Android, HTML5), and they often present user-friendly interfaces, such as Magpi,[28] that allow people to easily design mobile questionnaires. In Formhub and Magpi, forms can be shared with mobile data collectors and the data visualized in real time on a map, as the data are collected.

National-level systems have also been developed for widespread use, such as the open-source District Health Information Software 2 (DHIS2) system, currently used in a number of countries for routine health collection and reporting.[29] In addition to being integrated into national health information systems, DHIS2 accepts data from authorized mobile devices and can allow management of data at the individual (such as district) or aggregate (national) levels.[29]

5. Electronic Health Records

Electronic health records (EHRs) used to be connected only to the facilities they served, allowing clinical staff to access patient records through fixed desktop computers. But the advent of mHealth has redefined the boundaries of the EHR; now, health workers can electronically register the services they provide and submit point-of-care test results through mHealth systems to update patient histories from the field. Rural health workers at the point-of-care (for example, in rural clinics or in the patient's home) can access and contribute to longitudinal health records, allowing continuity of care that was previously impossible in non-hospital-based settings.[30] Server-side algorithms to identify care gaps or trends in key indicators, such as weight loss or blood-glucose fluctuations, shift the onerous burden of identifying patterns and generating cues-to-action away from human reviewers.

Among the earliest mHealth projects were those that allowed collection of survey or patient data through mobile phones.

OpenMRS, a popular mHealth-enhanced EHR, allows frontline health workers to access information from a patient's health record using a mobile device and to contribute information into the health record—for example, about field-based tuberculosis (TB) treatment.[30] Other systems, such as RapidSMS or ChildCount+, might not be linked to a clinical file but still can maintain longitudinal client histories, such as antenatal care documentation, infant and child growth records, and digital vaccine records.[23,31–32]

6. Electronic Decision Support: Information, Protocols, Algorithms, Checklists

Point-of-care decision support tools through mobile phones can help ensure quality of care.

Ensuring providers' adherence to protocols is a paramount challenge to implementing complex care guidelines. In particular, shifting tasks, such as screening responsibilities, from clinicians to frontline health workers often entails adapting procedures designed for clinical workers to cadres with limited formal training. mHealth initiatives that incorporate point-of-care decision support tools with automated algorithm- or rule-based instructions help ensure quality of care in these task-shifting scenarios by prompting frontline health workers to follow defined guidelines.

Electronic decision support tools also can be used to identify and prioritize high-risk clients for health care, targeting interventions in resource-limited contexts. e-IMCI (electronic-Integrated Management of Childhood Illnesses), for example, provides community health workers with mobile phone-based, step-by-step support to triage and treat children according to WHO protocols for the diagnosis and treatment of common childhood diseases.[33–34] In addition, several groups are developing mobile phone-based checklists to help reduce clinical errors or to ensure quality of care at the point of service delivery.[35]

7. Provider-to-Provider Communication: User Groups, Consultation

Providers can use simple voice communication through mobile phones to coordinate care and provide expert assistance.

Voice communication—one of the simplest technical functions of mobile phones—is among the most transformative applications in an mHealth service package, allowing providers to communicate with one another or across hierarchies of technical expertise. Once a key feature of telemedicine strategies, provider-to-provider communication by mobile phone can be used to coordinate care and provide expert assistance to health staff, when and where it is needed. Furthermore, communication is not limited to voice only; mobile phones allow the exchange of images or even sounds (for example, through digital auscultation, extending the reach of the traditional stethoscope) for immediate remote consultation.

Current examples of provider-to-provider communication include the establishment of ''Closed User Group'' networks in Ghana, Liberia, and Tanzania by the NGO Switchboard, by which members of each mobile phone group can communicate with one another at heavily discounted rates, or for free.[36–37] In Nigeria, an mHealth feedback loop between rural clinics and diagnostic laboratories reduces the turnaround time between HIV testing and result reporting to facilitate prompt care and referral.[38]

8. Provider Work Planning and Scheduling

Work planning and scheduling tools help keep health care workers informed through active reminders of upcoming or due/overdue services, and they promote accountability by prioritizing provider follow-up. In low-resource settings, there often is a shortage of providers, making it a challenge to provide systematic population follow-up using traditional paper-based methods. mHealth systems can facilitate the scheduling of individuals listed in population registries (described in application number 3) for household-based outreach visits.

Examples of this application include scheduling antenatal and postnatal care visits; alerting providers or supervisors about missed vaccinations or reduced adherence to medication regimens; and following up about medical procedures, such as circumcision or long-acting and permanent family planning methods. Provider work planning tools are common in many mHealth service packages, such as the scheduling functions of TxtAlert[39] and the MoTech ''Mobile Midwife Service'' that alerts nurses about clients who are due or overdue for care, to prevent missed appointments and delays in service provision.[40]

9. Provider Training and Education

Continuing medical education has been a mainstay of quality of care in high-income settings. Now, mobile devices are being used to provide continued training support to frontline and remote providers, through access to educational videos, informational messages, and interactive exercises that reinforce skills provided during in-person training. They also allow for continued clinical education and skills monitoring—for example, through quizzes and case-based learning.

Applications for provider training include eMOCHA,[41–42] a platform that allows frontline health workers in rural Uganda to select streaming video content as part of continuing education. eMOCHA recently released ''TB Detect,'' a free application for Android devices in the Google Play Store, allowing providers to access continually updated educational content about tuberculosis prevention, detection, and care.

10. Human Resource Management

Community health workers often work among rural populations, with only sporadic contact with supervisory staff. Web-based dashboards allow supervisors to track the performance of community health workers individually or at the district/regional/national level, either by noting the volume of digital productivity or by real-time GPS tracking of workers as they perform their field activities. This enables supportive supervision to those workers who may be lagging in their performance, while also enabling the recognition and reward of exceptional field staff.

These approaches are embedded within a number of mHealth service packages, such as Rwanda's mUbuzima, which helps supervisors monitor community health worker performance and provide performance-based incentives,[43–44] and UNICEF's RapidSMS in Rwanda, which enables supervisors to monitor exchange of SMS messages between community health workers and a central server, thereby measuring service accountability and responsiveness of community health workers.[24,45]

11. Supply Chain Management

mHealth tools to track and manage stocks and supplies of essential commodities have received significant global attention. Relatively simple technologies that allow remote clinics or pharmacies to report daily stock levels of drugs and supplies, or to request additional materials electronically, have been implemented in a number of countries.

In Tanzania, at least 130 clinics are using the SMS for Life mHealth supply chain system to prevent stockouts of essential malaria drugs.[46–48] Pharmacists and other service providers are trained to send their district-level supervisors a structured text message at the end of each week to report stock levels of key commodities including anti-malarials. The supervisors can then take necessary actions to redistribute supplies, circumventing a potential crisis.

In addition, a number of projects have developed mHealth strategies to reduce the risk of purchasing counterfeit drugs in countries where this is a major public health threat.[49] Companies such as Sproxil have partnered with drug manufacturers to provide mHealth authentication services to the purchasing public.[49] These strategies may help improve supply chain transparency and bolster a system's ability to be proactive and responsive to supply needs, with district or national-level visibility of performance.

12. Financial Transactions and Incentives

mHealth and mFinance are converging rapidly in the domain of financial transactions to pay for health care, supplies, or drugs, or to make demand- or supply-side incentive schemes easier to deploy and scale. These strategies focus on decreasing financial barriers to care for clients, and they are testing novel ways of motivating providers to adhere to guidelines and/or provide higher quality care. Mobile financial transactions are becoming increasingly common. For example, a single African network operator, MTN, estimated having 7.3 million mobile money clients in mid-2012.[50] Thus, providing incentives to clients to use particular areas of health services will be increasingly attractive (for example, for institutional deliveries or vaccines, vouchers to subsidize health services, universal health insurance schemes, and mobile banking for access to resources for health services[51]). Mobile-based cash vouchers have also been used where mobile money is not standard, as illustrated by the use of conditional cash transfers in Pakistan to provide families with an incentive to immunize their infants.[52–53]

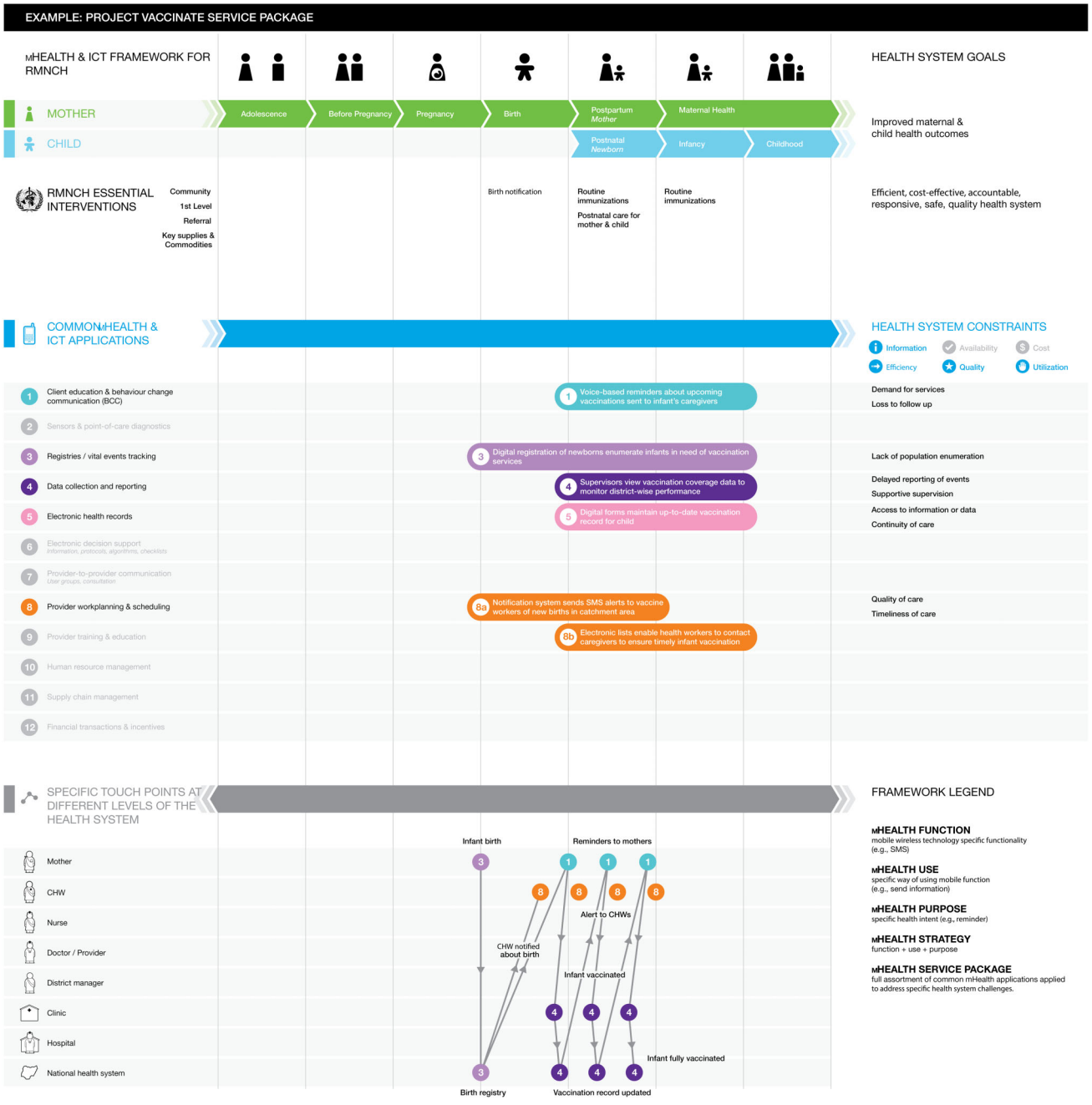
Many countries use mHealth tools to track and manage stocks of health commodities.

PLACING THE 12 APPLICATIONS WITHIN THE RMNCH FRAMEWORK

One illustration of the application of component parts of our framework is the display of mHealth projects working within the RMNCH continuum to improve health systems functions. Specifically, the common mHealth applications capture the core uses of mobile technology and their contribution toward meeting health system needs. Health system challenges and constraints in the framework embrace and draw from concepts articulated in the WHO building blocks of health systems (service delivery, health workforce, health information systems, access to essential medicines, financing, and leadership/governance).[54] The framework's intended audience ranges from mHealth projects—to help locate their work within a broader context of mHealth in the RMNCH landscape—to stakeholders in government, implementation, or donor communities.

In brief, the framework begins with the RMNCH continuum of care for women of reproductive age and their children to establish "when" during the reproductive life cycle the mHealth project will focus.[55] In other words, it identifies the

FIGURE 3. Sample Application of the mHealth and ICT Framework for RMNCH



Abbreviations: CHW, community health worker; ICT, information and communications technology; RMNCH, reproductive, maternal, newborn, and child health.

The fictional ''Project Vaccinate'' is an mHealth system that integrates 5 of the 12 common mHealth applications to identify newborns and support families and community health workers in ensuring timely and complete vaccination.

beneficiary targets of the mHealth strategy, such as adolescents or pregnant women, as well as the intended users of the system, such as community health workers or district supervisors.

Next, the framework identifies which RMNCH essential interventions (including preventive and curative care for improved maternal and child health outcomes) the mHealth approach will target, such as pregnancy registration or management of childhood illnesses.[56–57] This helps maintain focus on the needs of the health system and on the intervention that the mHealth approach is facilitating,[7] rather than on the technology being used.

The common mHealth and ICT applications used by the project are indicated by horizontal, colored bars running across the RMNCH continuum of care, from adolescence to pregnancy and birth to childhood. The framework also incorporates space (to the right of the colored bars) to succinctly describe the specific health system constraints that the project is addressing (for example, ''delayed reporting of events''). The framework includes categories of common health system challenges, such as information, availability, and cost. Finally, the ''touch points'' layer in the lower portion of the framework allows for mapping the mHealth-facilitated interactions among health system actors (for example, client, provider, manager, hospital, national health system).[58] See Figure 3 for an illustrative example of the fictional ''Project Vaccinate.''

A detailed description of the components and use of the framework are beyond the scope of this commentary. In the near future, we will provide an updated framework and user guide as web-based, online tools that mHealth innovators and other stakeholders can use. Thus, the framework would serve to map and catalog mHealth service packages used across the RMNCH continuum, describing their work using a common language. As mHealth stakeholders begin to use this tool and employ this common language to describe their mHealth innovations, we expect to foster improved understanding between mHealth innovators and mainstream health system program and policy planners.

This framework not only helps individual projects articulate their mHealth strategies through a shared tool but also facilitates identification of gaps in innovation, solutions, and implementation activity by overlaying multiple projects onto a single visualization. Any remaining blank spaces in the central area of the framework will signal areas of the continuum where future mHealth attention and investment may be warranted. This would also help identify common mHealth applications not yet utilized to target particular health system constraints.

Ultimately, we hope these initial efforts at building consensus around a common taxonomy and framework will help overcome misgivings that mHealth innovations are the new ''verticals'' of this decade. Innovations in this space should be viewed not as independent, disconnected strategies but as vehicles to overcome persistent health system constraints. mHealth applications in this framework largely serve to catalyze the effective coverage of proven health interventions.

Rather than focus on technology, our new mHealth framework places emphasis on addressing health system needs.

Although shared frameworks are critical to communicating value, continued efforts to evaluate and generate evidence of mHealth impact are also necessary to sustain growth and mainstreaming of these solutions. These efforts should be complementary to improving the quality of deployments through end-user engagement, stakeholder inclusion, and designing for scale.[59]

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ORIGINAL ARTICLE

High and equitable mass vitamin A supplementation coverage in Sierra Leone: a post-event coverage survey

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In Sierra Leone, an intensive mass vitamin A supplementation (VAS) campaign to reduce under-5 mortality reached over 90% of children ages 6–59 months, eliminating coverage disparities among districts and between age groups. Delivering VAS with other essential maternal and child health interventions was key to the success.

ABSTRACT

Background: In Sierra Leone, children ages 6–59 months receive twice-yearly vitamin A supplementation (VAS) through Maternal and Child Health Week (MCHW) events. VAS coverage in 2011 was calculated using government tally sheets of vitamin A capsule distribution and outdated population projections from the 2004 census. We conducted a national post-event coverage (PEC) survey to validate coverage and inform strategies to reach universal coverage of VAS in Sierra Leone.

Methodology: Immediately following the November 2011 MCHW event, we conducted a national PEC survey by interviewing caregivers with children ages 6–59 months using a randomized 30X30 cluster design (N=900). We also interviewed one health worker and one community health worker in each cluster to determine their knowledge about VAS (N=60).

Results: VAS coverage was 91.8% among children ages 6–59 months, which was lower than the 105.1% reported through tally sheets. Coverage was high and equitable among all districts and between age groups (98.5% for infants ages 6–11 months and 90.5% for children ages 12–59 months). Major reasons for not receiving VAS were that the child was out of the area (42.4%), the household was not visited by community health workers (28.0%), and the caretaker was not aware of the event (11.9%).

Conclusion: Twice-yearly delivery of VAS through MCHW events achieved consistently high and equitable coverage in Sierra Leone. Universal coverage may be achieved through continued focus on communication and targeted outreach to hard-to-reach areas during the MCHWs.

BACKGROUND

Vitamin A supplementation (VAS) is one of the most cost-effective child survival strategies in areas where vitamin A deficiency (VAD) exists.[1–2] Strong evidence shows that in settings where VAD is prevalent, twice-yearly receipt of VAS by at least 80% of children ages 6–59 months reduces risk of mortality from measles by an average of 50%, from diarrhea by an average of 40%, and from all causes by 24%.[3–4] A study in India carried out in a programmatic setting did not demonstrate such impact, but the study and related expert comments underscore the important of validating VAS coverage data to drive programs.[5–6]

VAS delivery through integrated events, such as Maternal and Child Health Weeks (MCHWs), is the most efficient method for reaching high and equitable coverage. Over the past 15 years, roughly 80 countries have scaled up vitamin A interventions, including 41 of 45 priority countries in sub-Saharan Africa that have high under-5 mortality rates and/or high VAD prevalence.[7]

In 1999, Sierra Leone had one of the highest under-5 mortality rates in the world (242 per 1,000 live

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births)[8] and an estimated VAD prevalence of 47% among children ages 6–59 months.[9] That year, the Ministry of Health and Sanitation (MoHS) initiated large-scale VAS as part of its strategy to reduce child mortality.[10–11] Although locally produced palm oil (rich in carotenes, which are vitamin A precursors) is widely available in Sierra Leone, its use in infant and young children's diets appears limited.

The Ministry estimated VAS coverage from events implemented between 1999 and 2003, but they were based on tally sheets using outdated 1985 census data. To better assess VAS coverage and inform strategies to improve coverage nationally and among hard-to-reach populations, the MoHS, Helen Keller International (HKI), and the United Nations Children's Fund (UNICEF) implemented a **post-event coverage (PEC) survey in 2004.** According to the survey, VAS coverage among children 6–59 months of age was 68.2% compared with the reported 83.0% coverage based on tally sheets, with large disparities found among districts.[12] Coverage also varied between age groups, with only 41% of infants ages 6–11 months receiving VAS compared with 73% of children ages 12–59 months.

As a result of these findings, the MoHS, with technical support from HKI and UNICEF, revised their distribution plan for VAS events at both national and district levels and launched an intensive communication campaign targeting caregivers and health care workers. In addition, the MoHS Nutrition Department and the Expanded Programme on Immunizations (EPI) strengthened their partnership, so that VAS, catch-up vaccinations, and deworming were integrated into twice-yearly MCHWs. The aim of the MCHWs was to deliver a package of child survival interventions with universal coverage among children 6–59 months of age.

To measure the impact of the refined strategy, the partners implemented a **follow-up PEC survey in 2005.** National VAS coverage among children 6–59 months of age had increased from 68.2% in 2004 to 95.0% in 2005, with high coverage across districts.[12] Additionally, coverage disparities between age groups had declined, with 91.8% of infants ages 6–11 months and 95.5% of children ages 12–59 months receiving VAS.

Since 2005, high VAS coverage has been sustained, with over 80% coverage consistently obtained in all districts as measured by tally sheets (based on 2004 census projections). The sustained high coverage of VAS and other essential child survival interventions may have contributed to under-5 mortality reduction in the country, from 214/1,000 live births in 2005 to 200/1,000 in 2008 and to 185/1,000 in 2011.[8]

Integrating VAS campaigns with other essential maternal and child health interventions provides maximum efficiency and coverage.

These major reductions in child mortality indicate that the measure of VAS coverage by tally sheets—while based on census projections from 2004—is still imprecise as it uses the 2005 child mortality rate of 214/1,000 to determine the projected population.

To validate VAS coverage and inform strategic planning of the MCHWs, the MoHS and HKI conducted a **national PEC survey immediately after the November 2011 MCHW.** The survey used EpiSurveyor technology (currently called Magpi; https://www.magpi.com/) to collect data through mobile phones on VAS coverage and characterize the children who did not receive VAS during the November 2011 MCHW. The survey also evaluated the level of VAS awareness among caregivers and health care workers, including from where caregivers heard about VAS, to evaluate the quality of MCHW social mobilization activities. Coverage data from the PEC survey was compared with tally sheet data and population projections to determine the reliability of administrative data.

This paper discusses the 2011 PEC survey and how the findings will inform VAS program design in Sierra Leone.

METHODOLOGY

MCHWs and Mass Vitamin A Supplementation

Mass VAS for the November 2011 MCHW was conducted over 5 days using mixed delivery methods, including fixed distribution points by health workers (HWs) and door-to-door distribution by teams of community health workers (CHWs) consisting of one distributor and one record keeper. Other interventions administered concurrently included deworming with albendazole of children ages 12–59 months, screening and referral of underweight children using mid-upper arm circumference (MUAC), delivery of tetanus toxoid for women of childbearing age (15–49 years), and testing and management of pregnant women with HIV infection to prevent mother-to-child transmission (PMTCT). HWs and CHWs collected and reported daily tallies of vitamin A capsules distributed to primary health

units (PHUs), District Health Management Teams (DHMTs), and the EPI Unit of the MoHS.

PEC Sampling, Sample Size, and Survey Sites

We adapted the World Health Organization-EPI (WHO-EPI) cluster sampling methodology to determine the sample size for the PEC survey.[13–14] Using probability proportional to size sampling (PPS) methodology, we randomly selected 30 enumeration areas (EAs) representing all 14 districts in Sierra Leone, with support from the National Statistics Office using population data from the 2004 national census.[13]

Of the 30 EAs sampled, 11 were in the north, 7 in the east, 6 in the south, and 6 in the west. In each EA, we selected 30 households by going to a central location (for example, a church, mosque, or communal center), spinning a pen, counting the number of houses to the end of the cluster in the direction the pen pointed, and selecting a random house to start. In addition, we randomly sampled and interviewed one HW from the nearest health facility and one CHW in each EA (N=60).

Caregivers were eligible to participate in the survey if they had a child who was 6–59 months old in November 2011 (N=900). If there was more than one caregiver in the household, we chose one at random by writing down each eligible caregiver's name on a slip of paper, putting the paper slips in a hat or basket, and selecting one at random. If the caregivers had multiple children ages 6–59 months, we randomly selected one child to be the focus of the interview using the same methodology that we used for randomly selecting caregivers. We verified children's ages with health cards whenever possible. When health cards were not available, we estimated children's ages using a local event calendar.

We selected HWs and CHWs based on their availability at the nearest PHU. When there was more than one HW or CHW present, we randomly selected one using the simple ballot system described above.

Questionnaire Development and Training of Enumerators

We developed a standard, coded survey for caregivers and another for both HWs/CHWs and translated both into 3 local languages: Krio, Mende, and Themne. We programmed the English version of the questionnaire into Nokia X2-01 mobile phones using the EpiSurveyor mobile phone program.

Ten enumerators attended a one-day training session on vitamin A, VAS, PEC survey methodology, the survey questions, and EpiSurveyor. We paired the enumerators into 5 teams, with 2 teams conducting the PEC survey in the north and one team each conducting the PEC survey in the east, south, and west regions.

Each team of enumerators received 2 Nokia X2-01 mobile phones to enter data, hard copies of the questionnaires, chalk to mark the houses visited, and vitamin A capsules to help mothers recall VAS receipt. Surveyors marked each house with a code:

✓ PECS for a completed house

✓ PECS for a house to be revisited

N=PECS for a house with no eligible children

The enumerators first recorded the data onto hard copies of the questionnaires and then subsequently entered the data into the mobile phones at the end of each day. We deemed it safer in remote, hard-to-reach sites for enumerators to use hard copies rather than to use the mobile phones in public places. The EpiSurveyor account administrator cross-checked the data on the hard copies with the database data before analysis to ensure quality control. Enumerators completed data collection within one week, and we held a debriefing session a day later with them to get feedback on their challenges with conducting the PEC survey and with using EpiSurveyor.

Ethical Considerations

We did not offer compensation or any other incentive to survey respondents. To protect the confidentiality of respondent information, the enumerators did not record names or addresses. The MoHS responsible for medical research and ethics approved the study monitoring. The enumerators made courtesy calls to traditional village chiefs to explain the purpose of the PEC survey and to obtain their permission to conduct the survey. Because literacy rates are low in Sierra Leone,[15–16] we obtained informed verbal consent from caregivers, HWs, and CHWs and interviewed only those who gave their consent to participate in the study.

Statistical Analysis

All data were downloaded from mobile phones to the EpiSurveyor program, exported to Microsoft

Excel, and then cleaned by comparing the uploaded data to the responses on the hard copies. Frequencies and percentages were calculated to estimate VAS coverage and chi-squared tests were conducted to test for differences between groups. Proportions for caregiver data were weighted using the inverse of the probability of selecting a household within a cluster. Because the selection and clusters were done using PPS, sample weighting was implemented only at the household level. All data were analyzed using SPSS® Version 20.

RESULTS

Demographic Characteristics of Survey Respondents

We interviewed a total of 900 caregivers, 26 HWs, and 34 CHWs. Of the 900 caregivers sampled, we could not confirm the exact age for 5 children (0.6%) from the enumerators' forms. In addition, we determined that 16 children (1.8%) were under 6 months of age at the time of the MCHW based on their birth date or estimation of age by the local calendar of events. Of the 879 children confirmed to be 6–59 months during the November MCHW, 16% were 6–11 months old and 84% were 12–59 months old (see Table).

There was no significant difference between the number of boys (50.4%) and girls (49.6%) selected as the focus child of the interviews with caregivers. Of the 879 caregivers interviewed, 80% were mothers of the selected child, 11% were grandmothers, 4% were fathers, 1% were siblings, and 4% were other relatives. There were significantly more Muslim (64%) than Christian caregivers (36%) (P=0.001). Caregivers had child health cards in 86% of households.

Of the CHWs and HWs interviewed, 23 (38%) were men and 37 (62%) were women. Nearly half had more than 5 years of health work experience, one-third had 3–5 years of experience, and about 18% had 1–2 years of experience.

VAS Knowledge Among Caregivers and Health Care Workers

When asked about the benefits of VAS, caregivers said that it prevents sickness (42%), prevents blindness (22%), improves growth (9%), and reduces risk of death (6%). Of the caregivers surveyed, 24% correctly stated the first age at which infants should receive VAS (6 months), and 15% correctly stated how often VAS should be received (every 6 months until 59 months or at every MCHW). Major sources of information about VAS included HWs (38%), radio (30%), and CHWs (27%), with TV, posters, and friends and family listed as minor sources.

Caregivers received information about VAS mostly through health care workers and the radio.

HWs and CHWs responded that VAS prevents sickness and/or improves health (67%), prevents blindness (53%), reduces risk of death (28%), and helps with vision (18%). The majority of HWs/CHWs correctly cited the age of first VAS (93%) and the VAS dosage for children ages 6–11 months and 12–59 months (85% and 83%, respectively).

Of the HWs/CHWs interviewed, 85% could correctly state how often VAS should be received. The major sources of information about VAS among HWs and CHWs were in-service training

TABLE. Demographic Characteristics of Sampled Children and Caregivers

Characteristics	Male	Female	Total
Age, n (%)			
6–11 months	81 (57.0%)	61 (43.0%)	142 (16.2%)
12–59 months	362 (49.1%)	375 (50.9%)	737 (83.8%)
Religion, n (%)			
Muslim	277 (49.3%)	285 (50.7%)	562 (63.9%)
Christian	164 (52.2%)	150 (47.8%)	314 (35.7%)
Prefer not to say	2 (66.7%)	1 (33.3%)	3 (0.3%)
Total, n (%)	443 (50.4%)	436 (49.6%)	879 (100%)

Validating administrative data with post-campaign surveys helps to refine planning, supply chain management, and implementation of future VAS campaigns.

(67%) and job aids (10%). Minor sources of information included radio messages, pre-service training, and policy documents.

VAS Coverage According to the PEC Survey

Overall, 91.6% of caregivers reported that their child received VAS during the last MCHW. Few caregivers (2.5%) could not remember if their child had received VAS, and 5.9% reported their child did not receive VAS during the last campaign. Coverage for infants 6–11 months old was 98.5% and for children 12–59 months old, 90.5%. While the study did not have enough power to measure coverage in each district, coverage in all selected clusters was considered high, ranging from 86.7% to 97.8%.

Of the 5.9% of caregivers who reported their children did not receive VAS:

- 42.4% had been out of the area at the time of the MCHW
- 28.0% had homes that were not reached by the teams
- 11.9% were not aware of the MCHW
- 17.7% cited other reasons: the child was sick, the head of the family had refused, the family was busy, or VAS supplies had run out

Programmatic barriers to receiving VAS include lack of health worker outreach to certain locations and lack of caregiver awareness about the campaigns.

Sources of VAS included:

- 94.1% via door-to-door
- 4.4% via health centers
- 0.8% at nursery schools
- 0.7% from mobile teams

VAS Coverage Reported by the Ministry of Health

Based upon tallies of capsules utilized (1,266,861) and a target population projection from the 2004 census (1,205,077), VAS coverage reported by the MoHS for the November 2011 MCHW was 105.1%.

DISCUSSION

VAS coverage during the November 2011 MCHW event was 91.6% based on results of the PEC survey. This level was not drastically lower than the 105.1% reported through MoHS tally sheets, suggesting that the higher VAS coverage reported through the tally sheets may be due to underestimation of the target population from inaccurate census projections. The 3 PEC survey rounds (2004, 2005, and 2011) were useful to validate VAS coverage through the MCHWs and to refine the planning and strategic development process of VAS events to ensure high coverage.

Using the number of vitamin A capsules distributed as reported from tally sheets and the estimated coverage from the PEC survey, we estimate the actual target population of children 6–59 months of age as 1,369,579. This is 14% higher than the current target population of 1,205,077 used by the MoHS.

The modified population estimate is an important adjustment to ensure that the appropriate number of vitamin A capsules, albendazole, and vaccines for measles and polio are ordered for upcoming MCHWs to prevent shortages during the events. This may help to increase coverage, since in the PEC survey, 35% and 17% of HWs/CHWs reported a shortage of 100,000 and 200,000 IU capsules, respectively. PEC surveys will be necessary to measure future changes in coverage since administrative data is prone to over-reporting.[15]

Success Factors to High VAS Coverage

The high VAS and deworming coverage during the MCHWs in Sierra Leone is likely the result of many factors, including monthly macroplanning meetings at the national level, sufficient funding and distribution of resources to enable VAS distribution in hard-to-reach areas, social mobilization involving high-level dignitaries as well as community leaders, and daily debriefings to enable rapid responses to weak performing areas (see Box).

Similar to other countries, integration of VAS with other child survival strategies, including measles and polio immunizations, deworming, and MUAC screening, has been successful in increasing VAS coverage.[17] These interventions have been consistent over the years in Sierra Leone, making it difficult to single out the intervention that has had the greatest impact on mortality. It is likely that improvements in all child survival services have contributed to the decrease in under-5 mortality observed in Sierra Leone (see Figure).

Across countries, institutional support, leadership, and ownership have been crucial to the success of MCHWs.[18–19] In Sierra Leone, the MoHS and partners show their support and leadership by mobilizing resources to provide a platform for the campaign. In addition, launching the MCHWs at national, chiefdom, and zonal

BOX. High VAS Coverage in Sierra Leone: Success Factors

- Regular planning and coordination meetings by a MCHW taskforce, chaired by the Ministry of Health and starting at least 6 months prior to the MCHW
- Availability and use of microplanning tools
- Inclusion of MCHW into national and district workplans
- Use of a pre-verification questionnaire that is sent to all District Medical Officers (DMOs) to assess their district's preparedness for the MCHW
- Interactive trainings for supervisors, vaccinators, and distributors prior to the MCHW
- Use of door-to-door and temporary fixed-post strategies to reach target children
- Provision of fuel and transportation costs to DHMTs and national supervisors, as well as provision of boat hire for districts with riverine populations
- Extensive social mobilization including promotion by the President of Sierra Leone, the First Lady, Minister of Health, jingles, banners, press releases, radio discussions in 4 languages, announcements by town announcers, and performances by music and drama groups
- Supervision at all levels and daily meetings at the DHMT level during implementation to identify gaps and solve problems
- Post-event reporting of results and sharing lessons learned at district and national Task Force levels

levels provides the opportunity to solicit the participation of politicians and opinion, traditional, and religious leaders.

Barriers to VAS Receipt

Only a small number of children in Sierra Leone do not receive VAS services during MCHWs. The 2011 PEC survey identified lack of caregiver awareness of the MCHW event and lack of household visits by CHWs as barriers to VAS receipt. These barriers are similar to those found in the 2004 PEC survey, suggesting that additional targeted strategies are needed to deliver the MCHW package of services to these last hard-to-reach populations.

In addition, caregivers' knowledge of the impact of VAS on mortality needs to be strengthened. Increasing caregivers' awareness of VAS benefits and ensuring that key information on the MCHW events is disseminated may increase demand for these services. From the PEC survey, suggested effective forms of communication include radio broadcasting and traditional methods, including message dissemination through HWs and CHWs.

Experiences With Mobile Phone Data Entry

We had a very positive experience using EpiSurveyor for the PEC survey, as it allowed the investigators to view raw data and summary statistics in real time, address questionable data while enumerators were still in the field, and quickly prepare the final report since the time needed for data entry was greatly reduced. Over 99% of the data entered with EpiSurveyor matched data from the paper surveys.

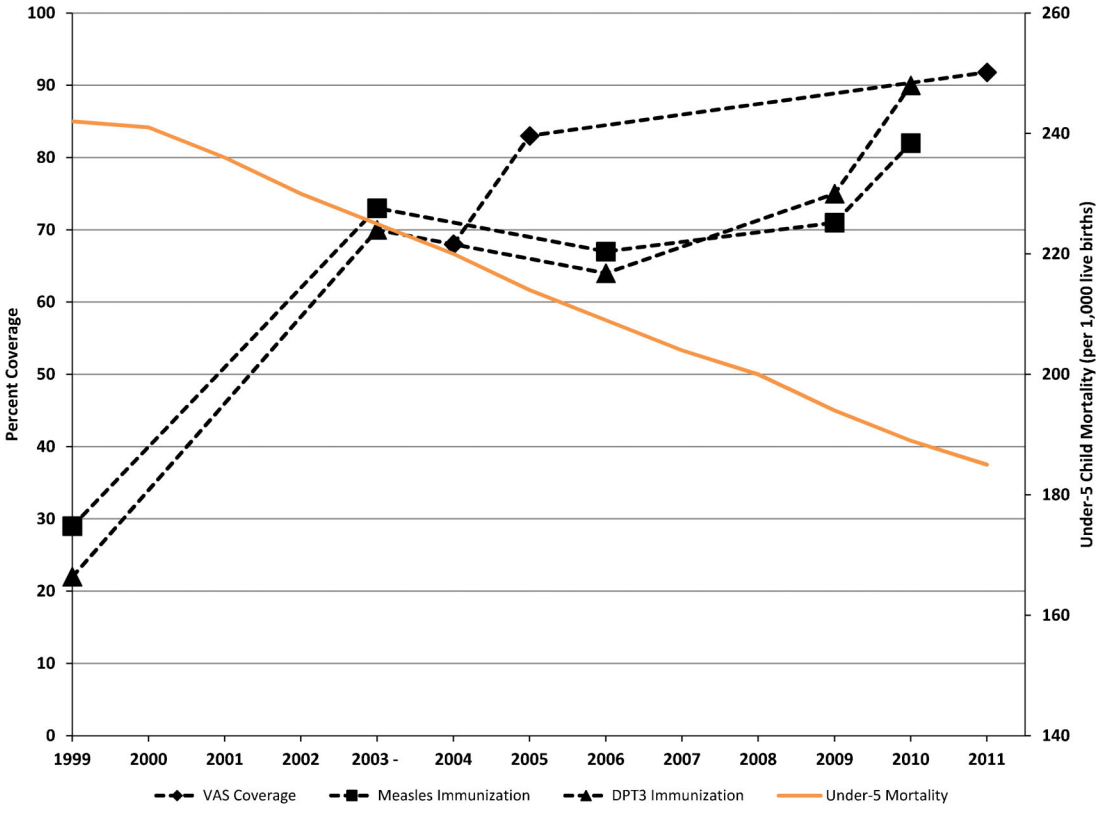
Limitations

EA selection for the PEC survey was based on the 2004 national census—the most recent comprehensive population count for Sierra Leone available at the time. But the census data are widely acknowledged to be unrepresentative of the post-conflict situation, which includes rapid urbanization, unmonitored settlement of internally displaced people, and recent labor migrations due mostly to the mining sector.[20] As a result, random selection of EAs was likely based on imprecise data, potentially leading to the selection of clusters with more populations that have migrated and the selection of fewer clusters in recently urbanized areas. Since 2012, it has become accepted at the national level to use a census conducted for mass drug administration to adjust population projections for VAS campaigns.

CONCLUSIONS

High VAS coverage has been achieved in Sierra Leone through twice-yearly delivery of VAS through MCHW events. The MCHW events have driven equitable access to VAS and other essential child survival services in Sierra Leone.

FIGURE. Changes in Under-5 Mortality and Coverage of Major Child Survival Interventions, Sierra Leone, 1999–2011



Abbreviations: VAS, vitamin A supplementation; DPT3, 3rd dose of the diphtheria, pertussis, and tetanus vaccine.

Results of the PEC survey indicate that outdated population data have led to higher VAS coverage reported through tally sheets and suggest that population data be reviewed to improve supply procurement estimates and increase the quality of coverage estimates.

The 2011 PEC survey confirms the major improvements in VAS coverage recorded between 2004 and 2005. Coverage in all districts was high, which demonstrates consistent quality of MCHW implementation nationally. Efforts to increase coverage among hard-to-reach populations should focus on increasing awareness of MCHW events and the impact of VAS on mortality.

High coverage of VAS and other essential child survival interventions through MCHW events has most likely contributed to the reduction in child mortality observed in Sierra Leone since 2005. Continuing the trajectory of high and equitable coverage of VAS through the MCHW events may enable Sierra Leone to achieve Millennium Development Goal 4: reducing child mortality by two-thirds to 90/1,000 by 2015.[21–22]

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ORIGINAL ARTICLE

Client-centered counseling improves client satisfaction with family planning visits: evidence from Irbid, Jordan

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In Irbid, Jordan, a combination of community outreach, using home visits, plays, women's groups, and religious leaders, and improved client-provider counseling based on the ''Consult and Choose'' approach increased family planning demand and client satisfaction. Service statistic trends suggest increased contraceptive use.

ABSTRACT

Background: High levels of unmet need for family planning and high contraceptive discontinuation rates persist in Jordan, prompting the Jordan Health Communication Partnership (JHCP) to initiate a client-centered family planning service program called ''Consult and Choose'' (CC), together with community-based activities to encourage women with unmet need to visit health centers.

Methods: We held exit interviews with 461 family planning clients between November–December 2011 to assess, from the clients' perspective, whether trained providers followed the CC protocol and used the CC tools, as well as to measure client satisfaction. We also tracked referral card information from community-based activities to health centers and examined service statistics to explore trends in family planning use.

Results: On average, clients reported that providers performed 5.6 of the 7 steps outlined in the CC protocol. Nearly 83% of respondents were very satisfied with their clinic visits. Logistic regression analysis found that the odds of being ''very satisfied'' increases by 20% with each additional counseling protocol step performed and by 70% with each increase in the number of CC materials used. Between June 2011 and August 2012, 14,490 referral cards from community-based activities were collected in health centers, 59% of which were for family planning services. Service statistic trends indicate an increase in the number of new family planning users and in couple-years of protection after starting the CC program.

Conclusions: Implementation of the CC program at health centers nationally, in tandem with community-based interventions, could play a key role in attaining Jordan's goal of reducing its total fertility rate to 2.1 by 2030. Although this initiative would likely be replicated most readily in other middle-income countries, lower-resource countries could also adapt the tested CC approach.

INTRODUCTION

Providers play a key role in a woman's decision to use contraception, as well as in which method she selects and her adherence to the chosen method.[1–2] One key element of Bruce's framework for assessing the quality of family planning services from the client's perspective is interpersonal relations between client and provider.[2] A study in Egypt found that client satisfaction was 3 times higher with client- versus provider-centered counseling, and continuation rates were higher at 7 months after the visit.[3] Another study found that providing information to clients about the hormonal IUD prior to inserting it was significantly associated with high client satisfaction.[4] Structured counseling greatly influences a client's choice of method[5] and is associated with lower discontinuation rates, particularly with the injectable *Depo-Provera®*, known to have a high discontinuation rate.[6] Additionally, a systematic review of the literature on the acceptability of the intrauterine device (IUD) demonstrated that women who received structured counseling and referrals from community workers had higher uptake of the IUD compared with women in control groups who received standard care.[7]

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Screening tools and client decision aids also can play a key role in enhancing the client's experience.[8] The use of the tools alone is limiting, however. For example, 2 independent studies in Nicaragua revealed that use of the World Health Organization's (WHO's) ''Decision-Making Tool for Family Planning Clients and Providers'' was not significantly associated with improved continuation rates,[9] even though clients were more satisfied with the counseling they had received. [9–10]

These findings are relevant to Jordan, where efforts to increase access to and use of modern contraception have been ongoing for several decades. The contraceptive prevalence rate (CPR) among married women ages 15–49 years is 59%, according to the 2009 Jordan Population and Family Health Survey (JPFHS).[11] Most married women report modern method use (42%), but 17% rely on traditional methods.

A 2006 study conducted in Ministry of Health (MOH) national health centers demonstrated that 16% of married women had an unmet need for family planning—that is, they wanted to avoid pregnancy altogether or for at least 2 years but were not using a method.[12] This unmet need was significantly and negatively associated with women's educational attainment. High levels of method discontinuation (45% of married women discontinue their method within the first 12 months of use)[11] contribute to unmet need in Jordan. The most cited reasons for discontinuation, besides wanting to become pregnant, are method failure (17%), wanting a more effective method (13%), and side effects (12%).[11]

Unmet need among married Jordanian women may be associated with the quality of family planning counseling they receive. A national qualitative study examining the knowledge, attitudes, and practices of family planning service providers from the MOH revealed that providers' personal beliefs greatly influence their counseling. Most providers were not convinced by the small family size concept, instead emphasizing the importance of a large family for one's social status and the preference for a male child.[13] The providers' religious beliefs influenced the type of method they recommended, and many providers indicated that they recommend short-term methods to married women with low parity and would not suggest, for example, the IUD for such women for fear that it would affect their fertility.[13]

Moreover, most providers reported that they did not provide family planning counseling due to time constraints. When they did counsel clients about family planning, it was often rushed, conducted in an open setting, and incomplete in that most physicians failed to discuss the side effects associated with the client's chosen method.[13] Surprisingly, most service providers acknowledged that improper counseling results in discontinuation and an increase in unmet need.[13]

In response to high discontinuation and unmet need rates, the Jordan Health Communication Partnership (JHCP) sought to enhance the quality of service provision by strengthening providers' counseling skills and approach through the ''Consult and Choose (CC)'' program. The program was informed by the understanding that behavior change is a function of beliefs, attitudes, and intentions[14–15] that are influenced by external factors, such as perceptions about the social normative practices of peers, socioeconomic circumstances, and the broader health care system.

In the context of the decision to use contraception, on the individual and social-network levels, couples must be convinced that a small family is beneficial, feel the need to space their children, be free of familial pressure to have large families, and be sufficiently informed to distinguish between rumors and facts. In addition, each woman has to feel that she is capable of delaying or preventing her pregnancy and that modern contraceptives are safe. At the same time, she needs to have ready access to contraceptive products and services, including professional counseling (systemic factors).

The guiding hypothesis of the CC approach was that the more comprehensive the communication interventions, the more positive the clinic experience. This positive experience would then be associated, in turn, with increased adoption and sustained use of modern contraceptive methods.

Provider biases can restrict clients' choice of contraceptive method.

In this article, we describe the CC program design and implementation; present findings on whether health care providers' use of the CC materials is associated with clients' satisfaction; and discuss implications of the CC experience for other middle-income countries. (Testing whether satisfaction with clinic visits is associated with the adoption and sustained use of modern methods was beyond the scope of our evaluation.)

THE CONSULT AND CHOOSE INTERVENTION

The CC program is part of the larger Irbid Initiative that takes into account several (but not all) personal and systemic factors that influence family planning use and is based on a ''push-pull'' approach. Community-level interventions encourage women to go the health center while advocating for husbands to support their wives' decisions (the push factor). Concurrently, the program equips health service providers with the necessary tools and skills to interact effectively with their clients so they can help clients make appropriate choices (the pull factor).

The overall objectives of the CC program are to:

- Increase the percentage of women using modern contraception
- Create a sense of belonging between modern contraceptive users
- Empower potential and current contraceptive users by connecting them with health centers as resources for accurate, credible, trustworthy family planning-related information and quality services (based on *Hayati Ahla* [My Life is Better] messaging, the national family planning campaign)
- Introduce counseling as a partnership between the client and service provider for informed decision-making
- Overcome service providers' biases by fostering professionalism and positive attitudes about modern contraceptives, pregnancy spacing, and small family size

The Push Factor

Arab Women Speak Out™ brings together women from the community to discuss marriage and family health issues.

The Irbid Initiative gave technical and financial assistance to 9 Community Health Committees in Irbid governorates to implement community-based interventions, such as plays, debates, awareness sessions, and home visits. Another key community-based activity was Arab Women Speak Out™ (AWSO™), which brought together groups of about 20 women of reproductive age to discuss issues related to marriage and family health, including contraceptive use and the need to go to the health center. Guided by a facilitator and inspired by stories of role models, the discussions revolved around issues and beliefs related to family planning, thus bringing these traditionally private topics to the public sphere. AWSO™ addressed predisposing factors of knowledge, attitude, beliefs, and values as well as enabling factors, such as the supporting environment and community. Participants received flash cards containing summaries of key topics so that they could then disseminate the messages to others within their community.

In addition, all 776 religious leaders in Irbid attended a 3-day training program that focused on family health and highlighted Islam's approval of family planning and modern contraceptives. Through sermons and religious lessons in mosques, religious leaders conveyed their approval of family planning, thereby overriding the notion held by a small, but sometimes vocal, group that Islamic precepts prohibit modern contraception.

Finally, all health promoters, one from each health center in Irbid, were trained to use JHCP's materials so that they could play a more effective role in promoting family planning in a given health center's catchment area.

The project hypothesized that the push factor would get women to the clinics.

The Pull Factor

The CC program blends the approaches recommended by the literature on family planning counseling into a single package for use by health care providers trained to use the following nationally distributed materials (see http://www.k4health.org/toolkits/jhcp/family-planning-service-provision-toolkit):

- The WHO's Medical Eligibility Criteria Wheel for Contraceptive Use and *Family Planning: A Global Handbook for Family Planning Providers* with the accompanying Family Planning Wall Chart (published jointly by the Johns Hopkins Bloomberg School of Public Health Center for Communication Programs and WHO), which provide detailed medical information relating to contraindications and eligibility for each contraceptive method
- Service Provider Cue Cards for 8 contraceptive methods, which include a picture of the method, description of its effectiveness, major advantages and side effects, how to manage side effects, and how to use the method
- Client Cue Cards for every modern method that the client takes home, which includes a picture and the name of the client's chosen

method, when to return, how to deal with side effects, grace period if a dose is missed, pointers for a dialogue with one's husband, and religious messages

- Posters displaying the clinic's promise to provide high-quality services to the client

Providers in Irbid had previously received extensive 5-day training in family planning counseling techniques and approaches by another agency. In 2010–2011, the CC program trained all Irbid family planning service providers during a half-day session to orient them on the CC tools and to reinforce proper counseling. Using a film produced by JHCP that models proper counseling (using the Rapport Building, Exploration, Decision-Making, Implementation counseling framework[16]) and use of the CC materials as a starting point, participants had an open and frank discussion about their own counseling practices.

The CC tools help limit the negative effects of any provider biases by providing step-by-step guidelines that adhere to internationally recognized standards. Proper counseling sessions using the CC approach typically last from 5 to 15 minutes, depending on whether clients are new or returning. After the training session, participants received a branded *Hayati Ahla* lab coat (although a few female providers preferred to continue wearing the traditional long blue lab coat) and pin, and they gave an oath to adhere to proper CC counseling.

JHCP, in collaboration with the MOH, also produced a 15-minute film for clients titled *Hayati Ahla*. The video was shown in maternal and child health (MCH) waiting areas in 6 Irbid-based centers and included information about JHCP and all its government and non-governmental partners, campaign ads by JHCP and its partners, and information about the MCH center. It also included short testimonials about post-abortion family planning and family planning advice and guidance from influential professionals from the health sector.

The project hypothesized that the ''pull factor'' activities would contribute to clients' overall satisfaction. The guiding hypothesis of the CC approach was that overall satisfaction would be high in the sampled centers, that satisfaction would be correlated with providers' use of CC materials and adherence to counseling guidelines, and that beneficiaries who received CC materials would read them and find them useful. In addition, we hypothesized that the *Hayati Ahla* film in waiting areas would have high rates of viewership and that viewers would recall messages that correspond to the film's content.

METHODOLOGY

We conducted exit interviews with family planning clients at MCH centers to evaluate, from their perspective, providers' adherence to the CC counseling protocol and use of CC materials, as well as to assess client satisfaction with the counseling experience. We also tracked referrals to health centers from community-based activities and used service statistics from the MCH centers to explore contraceptive use trends since starting the CC program.

The Jordanian MOH reviewed and approved the evaluation protocol and the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health provided ethical approval for the evaluation.

Exit Interviews at MCH Centers

Sample Selection

We relied on a post-test only single sample design because we distributed CC materials to MCH centers throughout Jordan, thus eliminating the option of a control sample.

We stratified the sample by district and selected 20% of the 100 MCH centers in the 9 districts in Irbid. We based selection on client flow, so we included centers with the highest number of family planning beneficiaries in the sample. Centers that showed the *Hayati Ahla* video were automatically included. All selected centers provided IUD services.

Women were randomly selected for screening prior to inclusion in the evaluation. Women ages 15–49 and who were engaged or married at the time were eligible for inclusion. Women who met these criteria were then asked to specify why they were visiting the MCH center. Of the randomly selected women, those who were visiting the center for any family planning service were included in the evaluation. Family planning services included obtaining a method, receiving counseling, and/or following up or consulting about a currently used method.

Questionnaire

The interviewer-administered questionnaire included 28 questions about demographic characteristics, the family planning counseling or

service experience, and satisfaction with the health center. We also asked women who were visiting the 6 health centers that displayed the *Hayati Ahla* video an additional 11 questions about the video. No identifiers were collected.

Data Collection, Entry, and Analysis

All interviews took place after the client exited from her session with the health care provider. When referring to CC materials used during counseling or consultations, the interviewers showed the respondents the CC materials of interest. We assessed providers' use of CC materials, including the medical eligibility criteria wheel, provider and client cue cards, and the *Hyati Ahla* lab coat, based on the client's recollection of the provider using these materials. Internal consistency of the resulting scale was satisfactory (Cronbach's alpha=0.67). We also assessed providers' adherence to the CC family planning counseling protocol based on the client's recollection of the provider discussing 7 key issues before choosing a method, such as ideal family size and advantages and disadvantages of available methods, as well as how to manage side effects of the client's chosen method (Cronbach's alpha=0.86).

We assessed client satisfaction using a 4-point scale (very satisfied, somewhat satisfied, dissatisfied, or very dissatisfied). We instructed interviewers to select a pre-coded response of ''unsure or no opinion'' if the client expressed uncertainty or neutrality. We then transformed the scale into a dichotomous variable, where a positive response was recorded when the beneficiary was ''very satisfied,'' for the data revealed that most beneficiaries where somewhat or very satisfied.

The research team used CSPro 4.0, a public-domain software package for entering, editing, and tabulating survey data. The data set was cleaned and edited for inconsistencies. Missing data were not statistically included. We used STATA version 11 statistical software to complete the data analysis.

Chi-square testing was used to determine statistical significance when comparing proportions. Stepwise multivariate logistic regression analysis was conducted to explore the relationship between the odds of being very satisfied with the odds of not being very satisfied and the adherence to proper family planning counseling and use of CC materials, while accounting for age and educational attainment.

Service Statistics

To measure the mobilization effect of the community-based interventions, women who had participated in AWSO^{TM} or who had attended community-based activities or sermons and who had unmet health needs were given a ''referral card'' to take to an MCH center when they sought services. Referral card information was recorded at the center and sent to the MOH's quality control department on a monthly basis for analysis, which was then fed back to the field.

We also used 2 measures from service statistics collected from MCH centers in Irbid over the past 4 years to examine trends in family planning use:

- Number of new family planning clients: A woman who visits the MCH center for any family planning service for the first time is entered into the MCH information system as a ''new client.'' Data were summed from each of the 9 districts in the Irbid governorate as a surrogate measure for family planning demand (being a ''new client'' does not necessarily reflect uptake of a contraceptive method).
- Couple-years of protection (CYP): The CYP for the specified time periods was calculated by the Irbid health directorate and validated at the central level of the MOH.

RESULTS

Quantitative Findings From Exit Interviews

Recruitment and Characteristics of Respondents

We completed 461 client interviews between November 23, 2011 and December 5, 2011. About three-quarters of the women (n=352) received family planning counseling during that day's visit (Table 1). A total of 277 were there to follow up or consult about a method they were already using, 234 of whom had been counseled on their method of choice at the health center during a previous visit. Because the CC materials were primarily to facilitate choosing or switching to a new method, follow-up clients who were not switching methods may have been exposed to the CC materials only at their initial visit. Therefore, only follow-up clients who received counseling during a previous visit were asked about use of the CC materials.

All respondents were of reproductive age, with an average age of 30 years. Slightly over half (54%) of the respondents were 30 years old or younger, 40% were 31–40 years old, and only 6%

TABLE 1. Family Planning Services Sought by Clients

Type of Family Planning Service	Total No. of Clients	No. of Clients Who Received Counseling on Day of Interview	No. of Follow-Up Clients
	Received 1 Service		
Obtain a method	75	75	0
Counseling	36	36	0
Follow-up/consult	109	0	109
	Received 2 Services		
Obtain a method and counseling	73	73	0
Obtain a method and follow-up/consult	67	67	67
Counseling and follow-up/consult	54	54	54
	Received 3 Services		
Obtain a method, counseling, and follow-up/consult	47	47	47
TOTAL	**461**	**352**	**277[a]**

[a] Of the 277 follow-up clients, 234 received counseling during a previous visit at the health center.

were 41–49 years old (data not shown). Nearly all respondents were married and had, on average, 3.5 children (data not shown).

Adherence to CC Counseling Protocol

A total of 352 women visited the health center to obtain a contraceptive method or family planning counseling. Over 80% of respondents reported that the service provider had performed the following 5 tasks (data not shown):

- Asked her whether she had a certain method in mind before coming to the center
- Explained various contraceptive methods that were available and that she could use
- Made clear what the advantages were of different contraceptive methods
- Made clear what the disadvantages were of different methods
- Discussed possible side effects of methods

Service providers were less likely to discuss the client's desired family size (62%) or to talk about the advantage of birth spacing (73%). On average, providers had performed 5.6 of these 7 tasks.

In addition, 87% of respondents reported that the provider had helped them choose a method and 70% of respondents chose a method that day. Of those who chose a method, 81% said that the provider had discussed how to manage the side effects associated with that method and 94% said the provider had explained where to obtain the method.

Use of CC Materials

Women who received family planning counseling (n=352) were asked whether the provider had used CC materials. The material used most frequently was the client cue card; 73% of women reported that they had received a card during that day's visit, a near match with the 70% who reported that they had chosen a method that day. Nearly all of the women who received a client cue card expressed an intention to read the card at a later time.

About 68% recalled that the provider had used the provider cue card during the consultation and

65% noted that the provider wore the *Hayati Ahla* lab coat. Forty-four percent reported that the provider had used the wheel to identify the appropriate method.

A total of 277 women visited the health center to follow up about the method they were using at the time. Of these women, 234 had received family planning counseling at that particular center during a previous visit, 71% of whom recalled having received a client cue card during their previous visit to the health center. Nearly all of these women (98%) referred to the card once they went home, and all said that it was useful.

The Family Planning Wall Chart was noticed by 85% of all interviewed women, nearly all of whom (96%) reported that it was useful.

Client Satisfaction

About 4 women in every 5 were very satisfied with their visit on the day of the interview (data not shown). Satisfaction was associated with use of the CC materials, particularly the wheel, cue cards, and wearing the *Hayati Ahla* lab coat (Table 2), as well as with the provider following the CC counseling protocol (Table 3).

Usefulness of the Hayati Ahla *Film*

We interviewed 120 clients from the 6 health centers that piloted the *Hayati Ahla* film. Nearly one-fifth of respondents had heard about the video screen in the health center from others before visiting the center, and 62% noticed a large video screen on the wall of the waiting area. Among those who noticed the screen (n=74), 70% spent time watching the film while waiting.

The most recalled messages from the film were about (data not shown):

- Using modern methods or using contraceptive methods in general (81%)
- Spacing between pregnancies in general or spacing 3 years in particular (33%)
- Family planning counseling (14%)
- The national family planning campaign slogan of *Hayati Ahla* (14%)

As shown in Table 4, 85% of those who watched the film reported that the film influenced them. Of these, over one-third indicated that they felt more positive about using family planning and that they would now plan their families, and that they would use contraception

TABLE 2. Client Satisfaction Associated With Providers' Use of ''Consult and Choose'' Materials

Materials	Client Satisfaction, % (No. of Clients Reporting Provider Used Material)	Client Satisfaction, % (No. of Clients Reporting Providers Did Not Use Material)
Wheel	89.1* (n=156)	72.5* (n=196)
Provider cue card	83.8* (n=240)	71.4* (n=112)
Hayati Ahla lab coat	88.3* (n=230)	63.9* (n=122)
Received client cue card	86.9 (n=221)	81.2 (n=85)
Referred to the client cue card	89.9 (n=206)	86.7 (n=15)

Client satisfaction level was defined as ''very satisfied.''
* Significance comparing satisfaction between clients who recalled that their providers used materials vs. those who did not recall that their providers used the materials. *P* values ≤ .05 were considered statistically significant.

TABLE 3. Client Satisfaction Associated With Providers' Use of ''Consult and Choose'' Counseling Protocol

Counseling Protocol Task	Client Satisfaction, % (No. of Clients Reporting Providers Performed Task)	Client Satisfaction, % (No. of Clients Reporting Providers Did Not Perform Task)
Discussed how many children the beneficiary would like to have	87.7* (n=219)	66.9* (n=133)
Talked to the beneficiary about advantages of birth spacing	83.0* (n=259)	71.0* (n=93)
Asked the beneficiary whether she had a method in mind before coming to the center	82.7* (n=295)	64.9* (n=57)
Explained available methods that the beneficiary could use	81.4* (n=307)	68.9* (n=45)
Made clear the advantages of different methods	82.2* (n=297)	67.3* (n=55)
Made clear the disadvantages of different methods	81.7* (n=289)	71.4* (n=63)
Talked to the beneficiary about possible side effects of methods	82.8* (n=291)	65.6* (n=61)
Explained how to manage side effects of the chosen method	83.6* (n=305)	55.3* (n=47)

Client satisfaction level was defined as ''very satisfied.''
* Significance comparing satisfaction between clients who recalled that their providers performed the task vs. those who did not recall that their providers performed the task. *P* values ≤ .05 were considered statistically significant.

as a direct result of viewing the film. Nearly one-fifth said they would ask a doctor about family planning. Responses were spontaneous, not prompted.

All of the women said they would tell others about the film and 100% of the women believed that the video should be shown in all health centers.

Multivariate Analyses

To test whether the association between client satisfaction and use of CC materials and counseling protocol was confounded by educational attainment or age, multiple logistic regressions were conducted (Table 5). Results indicate no association between being ''very satisfied'' and respondents' age. Adding respondents' education to the equation increases the odds of being ''very satisfied'' by 30% with each increasing educational attainment category. However, this association is lost when the number of CC counseling protocol steps is inserted into the equation.

The odds of being ''very satisfied'' increases by 20% with each additional counseling protocol step performed and by 70% with each increase in the number of CC materials used.

The association between satisfaction and adherence to CC counseling protocol is lost when the number of CC materials used is incorporated into the equation, indicating that use of CC

TABLE 4. Effects of the *Hayati Ahla* Video on Viewers (n=52)

Effects Reported by Viewers	No. (%)
Will tell others about the video	52 (100.0)
Believe that such a display should be present in all health centers	52 (100.0)
Watching the video influenced the viewer	44 (84.6)
More acceptance of family planning/modern methods; less fear of modern methods	22 (45.5)
Will use contraception	16 (36.4)
Will ask doctor about family planning/modern methods	14 (31.8)
Will plan family/space 3 years between births	17 (38.6)
Will discuss family planning with spouse/others	10 (22.7)

materials is a key contributor to high client satisfaction. This confounding is not surprising since the number of CC counseling steps adhered to positively correlates with the number of CC materials used (r^2=0.5; P<.001, n=352).

About 60% of community-based referrals to health centers were for family planning services.

Descriptive Findings From Service Statistics

In total, 14,490 referral cards were collected in MCH centers in Irbid during start-up and implementation of community-based interventions and the CC program (from June 2011 through August 2012), 59% of which were for family planning services.

We used the MOH's database to assess trends in new family planning users and CYP between August 2008 and July 2012 to validate the mobilization effort recorded through the referral cards. Between August 2008 and July 2011 (prior to full implementation of the Irbid Initiative), the number of new family planning clients was stagnant at around 22,000 clients per year. After launching the Irbid Initiative, the number

TABLE 5. Multivariate Stepwise Logistic Regression Analysis of Variables Associated With Family Planning Client Satisfaction

Variable	Odds Ratios of Being "Very Satisfied" With the Visit				
	Model 1	Model 2	Model 3	Model 4	Model 5
Age categories[a]	1.4	1.5	1.3	1.4	1.4
Educational attainment categories[b]		1.3*	1.2	1.3	1.2
Adherence to counseling protocol[c]			1.2**	–	1.1
Use of counseling materials[d]				1.7***	1.6***
No. of observations	461	461	352	352	352

Each successive model reflects the addition of a new variable in the regression analysis to test which variables remain statistically associated with client satisfaction as each new variable is added.

* P<.05; **P <.01; ***P <.001

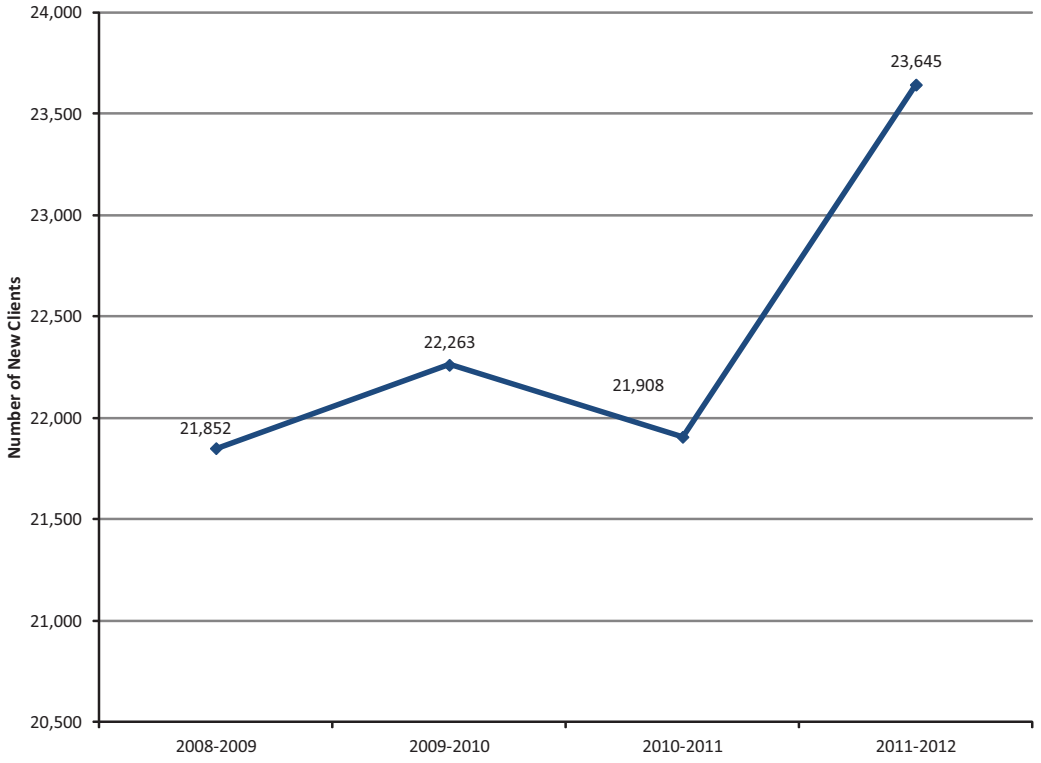
[a] Age categories: 18–20 years, 21–30 years, 31–40 years, 41–49 years.

[b] Educational attainment categories: Basic or lower, secondary, intermediate diploma, university or higher.

[c] Number of counseling protocol steps followed according to the client's recollection.

[d] Number of materials used during counseling according to the client's recollection.

FIGURE 1. Trends in New Family Planning Clients, Irbid Governorate, August 2008–July 2012



of new clients increased to more than 23,000 during the first project year (Figure 1).

Long-term methods such as *Implanon*® implants and IUDs increase the CYP. Implants are not readily available in MCH centers, but the IUD is the most preferred method in Jordan.[11] Both midwives and physicians used to insert IUDs until midwives announced in 2010 that they would no longer insert IUDs unless legislation was amended to meet their legal requirements, after which a decline in CYP was registered throughout Jordan. This decline has persisted except in Irbid, where a reversal is seen in mid-2010, which coincides approximately with implementation of the Irbid Initiative (Figure 2).

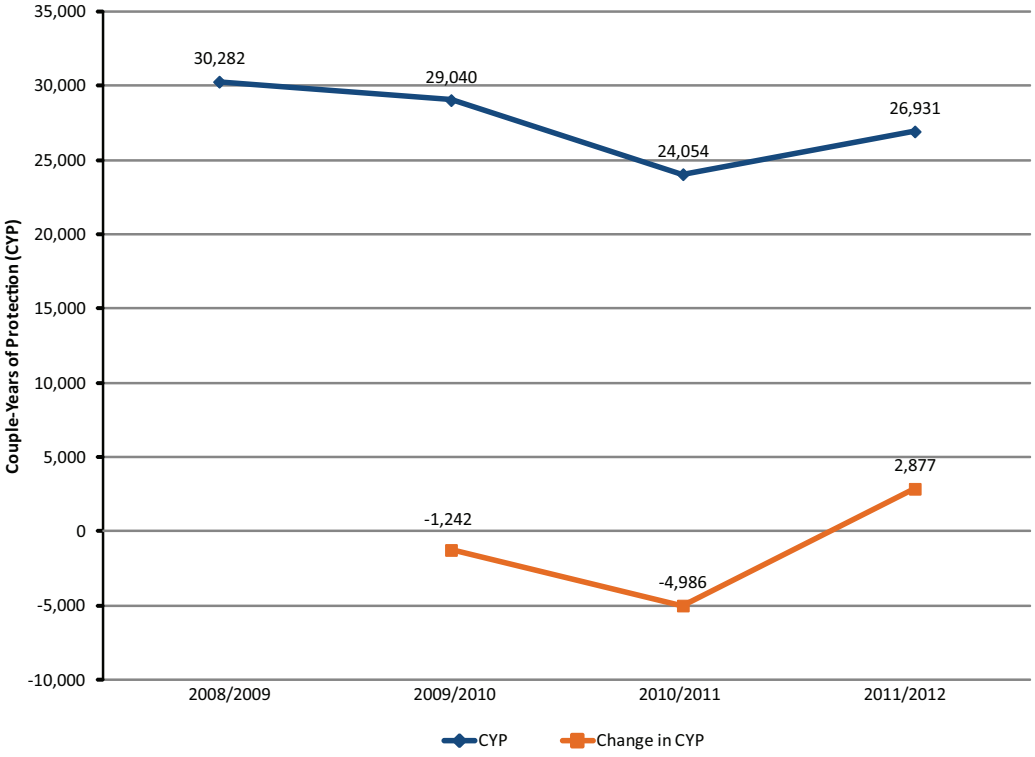
The Irbid Initiative did not attempt to address the shortage of female physicians, whom clients prefer over male providers for IUD insertion. However, the increase in CYP suggests—but does not prove—that the Irbid Initiative had positive effects in encouraging women to consider a broader range of methods given that the method mix most likely did not change from August 2008 through July 2012.

Limitations

This evaluation was conducted in a single governorate where all family planning providers were trained to use the CC materials. Program effects on client satisfaction are very likely underestimated because even providers who did not use the CC materials as recommended had attended training sessions to build their interpersonal communication skills. It would be useful to compare the experiences of clients who visited clinics where the providers were trained in the CC approach with clinics where providers were not trained in the approach.

Asking respondents about their level of satisfaction can result in some degree of respondent acquiescence bias, which may explain, in part, the overall high levels of satisfaction with clinic visits. Since the outcome of interest is the relationship between providers' use of CC materials and client satisfaction, and not the level of

FIGURE 2. Trends in Couple-Years of Protection, Irbid Governorate, August 2008–July 2012



client satisfaction, that potential limitation is partially mitigated.

The evaluation would have been strengthened if it had relied on third-party observation of counseling and service provision, for client recall of counseling procedures and the use of materials may have introduced a recall bias. The research team attempted to reduce recall bias by showing respondents the materials of interest and ensuring that the interview occurred within a half-hour after the beneficiary received the services.

The greater limitation, however, is that the evaluation did not follow up with the clients to assess whether use of the CC materials was associated with decreased levels of discontinuation and unmet need, the ultimate goal of the program. Although that question lies beyond the purview of this evaluation, it is an important question to address in a companion study.

Moreover, the promising trends in the CYP and new user numbers may be a result of factors external to the CC program and community-based interventions.

DISCUSSION

Improving the quality of care of family planning services is an important goal in Jordan given the high rates of contraceptive discontinuation and unmet family planning need. It is vital that technically competent health care providers offer all family planning clients, regardless of income or educational attainment, courteous treatment and information that is accurate, understandable, and appropriate for their needs. The assumption of the CC approach is that high-quality services, which can be enhanced with appropriate training, will lead to increased clinic visits, fewer women with unmet need, and lower discontinuation rates, all of which will contribute to higher CPR and, ultimately, lower fertility rates as has been discussed in the literature.[17–18]

In addition to these systems-level interventions, the CC program also benefited from community-based activities that encouraged women with an unmet need for family planning to come to the health clinic, which the program tracked through referral cards. Another advantage

was that the initiative was branded with the national family planning campaign logo—*Hayati Ahla*—that is displayed on all public service announcements promoting family planning, on all print materials at MCH centers, and in all community-based family planning events.

The findings demonstrate the utility of the CC approach given that client satisfaction with clinic visits was strongly and positively associated both with providers' use of the CC materials and with having a provider who, based on client perceptions, followed the CC counseling protocol. These findings add to data from other countries that showed a correlation between positive client-provider interactions with use of communication tools and enhanced client satisfaction, increased knowledge levels, and longer and more effective use of methods.[1,3] The evaluation results also provide further support for giving clients information about their chosen method,[4] for structured counseling,[5–7] and for using screening tools and client decision aids.[8] In addition, the family planning video shown in clinic waiting rooms amplified and extended messages about family planning, which also adds to the body of evidence about the synergistic effects of interpersonal and mediated communication.[19–20]

Jordan is approaching a critical stage in its development. Recent data show that Jordanians of working age (15–64 years) represent 59% of the population, and those aged 14 years or younger represent 37% of the population.[11] The total fertility rate (TFR) decreased from 5.6 children per woman in 1990 to 3.7 children in 2002[21]; however, since then, the TFR has stagnated at 3.8 children.[11] It is projected that Jordan will be able to realize its demographic opportunity—a state where the proportion of the working age population is at its highest and the age dependency ratio is at its minimum—only if the TFR decreases significantly by 2017 and continues its decline to 2.1 children by 2030.[21] The implementation of the CC program at MCH centers nationally, in tandem with community-based interventions, could play a key role in attaining this goal by increasing demand for, and satisfaction from, family planning services.

The authors hope that by sharing the findings from this evaluation, the CC initiative will be replicated in Jordan and beyond to foster greater client satisfaction and long-term, effective contraceptive use among couples who desire to delay or limit childbearing. Although this initiative would likely be replicated most easily in other middle-income countries that have undergone the epidemiological transition from infectious to chronic diseases, the CC approach also could be adapted to environments with fewer resources. The CC kit included materials that have been developed and tested internationally and could readily be adapted for use in other countries, even in low-resource settings. A video or training protocol could be created to demonstrate appropriate use of these tools by providers in a culturally appropriate and practical fashion. Likewise, JHCP's close collaboration with existing community-based groups for community outreach, exemplified by AWSO™, is another low-cost approach to community outreach that could be replicated. While lower-income countries may not have as many health facilities and providers who specialize in family planning service provision and counseling as in Jordan, the CC experience suggests that the appropriate and judicious use of family planning tools during clinic visits can enhance the counseling experience and lead to more satisfied family planning users.

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ORIGINAL ARTICLE

Food commodity pipeline management in transitional settings: challenges and lessons learned from the first USAID food development program in South Sudan

Hannah Tappis,[a] Shannon Doocy,[a] Stephen Amoako[b]

Efficient and reliable commodity transport is critical to effective food assistance in development settings as well as in emergency situations. Increasing the flexibility of U.S. government Title II food assistance program procurement regulations and more comprehensive contingency planning could improve the effectiveness of these programs in non-emergency settings with high food insecurity and political volatility.

ABSTRACT

Despite decades of support for international food assistance programs by the U.S. Agency for International Development (USAID) Office of Food for Peace, relatively little is known about the commodity pipeline and management issues these programs face in post-conflict and politically volatile settings. Based on an audit of the program's commodity tracking system and interviews with 13 key program staff, this case study documents the experiences of organizations implementing the first USAID-funded non-emergency (development) food assistance program approved for Sudan and South Sudan. Key challenges and lessons learned in this experience about food commodity procurement, transport, and management may help improve the design and implementation of future development food assistance programs in a variety of complex, food-insecure settings around the world. Specifically, expanding shipping routes in complex political situations may facilitate reliable and timely commodity delivery. In addition, greater flexibility to procure commodities locally, rather than shipping U.S.-procured commodities, may avoid unnecessary shipping delays and reduce costs.

BACKGROUND

Food assistance programs, which are complex in any setting, frequently face unanticipated logistical challenges in delivering the correct types and quantities of food in humanitarian situations, as well as in non-emergency situations where food insecurity can nevertheless be severe. Despite decades of support for such programs by the U.S. Agency for International Development (USAID) Office of Food for Peace (FFP), relatively little is documented about commodity pipeline and management issues in post-conflict settings beyond the internal program data used for monitoring and reporting. Moreover, new factors have come into play, including the increasingly prolonged nature of conflict and the global food, finance, and fuel crises. This evolution of the global and local environments in which food assistance programs function has implications for foreign assistance policy and practice. This case study aims to contribute to the evidence base by documenting the challenges faced and lessons learned from a food assistance program in South Sudan, an area undergoing a transition from relief to development programming at a time of substantial political change and instability.

Under the Food for Peace Act of 1954,* the USAID Office of Food for Peace is tasked with managing programs under Title II of the Trade portion of the Farm Bill, which provides for donation of U.S. agricultural commodities and humanitarian assistance to meet emergency and non-emergency food needs in other countries. Food aid provided under Title II is primarily targeted to vulnerable populations in foreign countries in response to malnutrition, famine, natural disaster, civil strife, and other extraordinary relief requirements. Title II resources can also be used to provide non-

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* Commonly known as Public Law 480; reauthorized as the Federal Agriculture Improvement and Reform (FAIR) Act in 1996, which is commonly known as the 1996 Farm Bill.

Changed global and local contexts require a review of food assistance policy and practice, particularly commodity pipeline issues in transitional settings.

emergency (development) assistance to address chronic malnutrition, boost agricultural productivity and incomes, and help build resilience in the most food-insecure countries with high levels of stunting and poverty.[1] In terms of program design, Title II emergency and development program activities are similar; the key difference is that emergency food programs often provide rations that are designed to meet a significant proportion, if not all, of a household's nutritional needs, whereas development programs incorporate a range of other activities and provide fewer targeted rations.[2]

USAID has provided food aid to Sudan (including the southern area now recognized as the Republic of South Sudan) for more than 20 years. Until 2010 this assistance was solely in the form of emergency aid.[3–4] The South Sudan Health, Nutrition and Empowerment (SSHiNE) program was the first Title II development food assistance program approved for implementation in Sudan and South Sudan. A consortium of nongovernmental organizations (NGOs) implemented the program. Its members consisted of Concern Worldwide, Food for the Hungry, Malaria Consortium, and the Adventist Development and Relief Agency (ADRA). ADRA, the lead agency in the consortium, has more than 50 years of emergency and development food assistance experience, including more than 20 years of experience in South Sudan and a history of successful non-emergency food assistance program implementation in post-conflict Bosnia, Mozambique, Nicaragua, and Zimbabwe.

The program was initially approved for implementation from July 2010 through June 2013 in the three South Sudanese states of Northern Bahr el Ghazal, Warrap, and Upper Nile (Figure 1). The launch of the project marked not only a transition in U.S. strategies for food assistance, linking relief to development in the region, but also coincided with a period of unprecedented political, economic, and social transition in the country. These transitions included the referendum for self-determination that took place in January 2011, the subsequent expiration of the Comprehensive Peace Agreement (CPA), and transition to independence in July 2011.

METHODS

As proposed, the SSHiNE program was a multi-year assistance program intended to reach 500,752 direct and 504,250 indirect beneficiaries, with a direct impact on the nutrition status of 40,420 children at an estimated total cost of US$55 million. The scope of the program was later reduced to cover a smaller geographic area, eliminating programming in Upper Nile State. This reduced the total number of beneficiaries to 251,904 direct and 250,000 indirect beneficiaries, with a direct impact on the nutrition status of 20,150 children, and shortened the implementation period by 1 year, ending in June 2012.

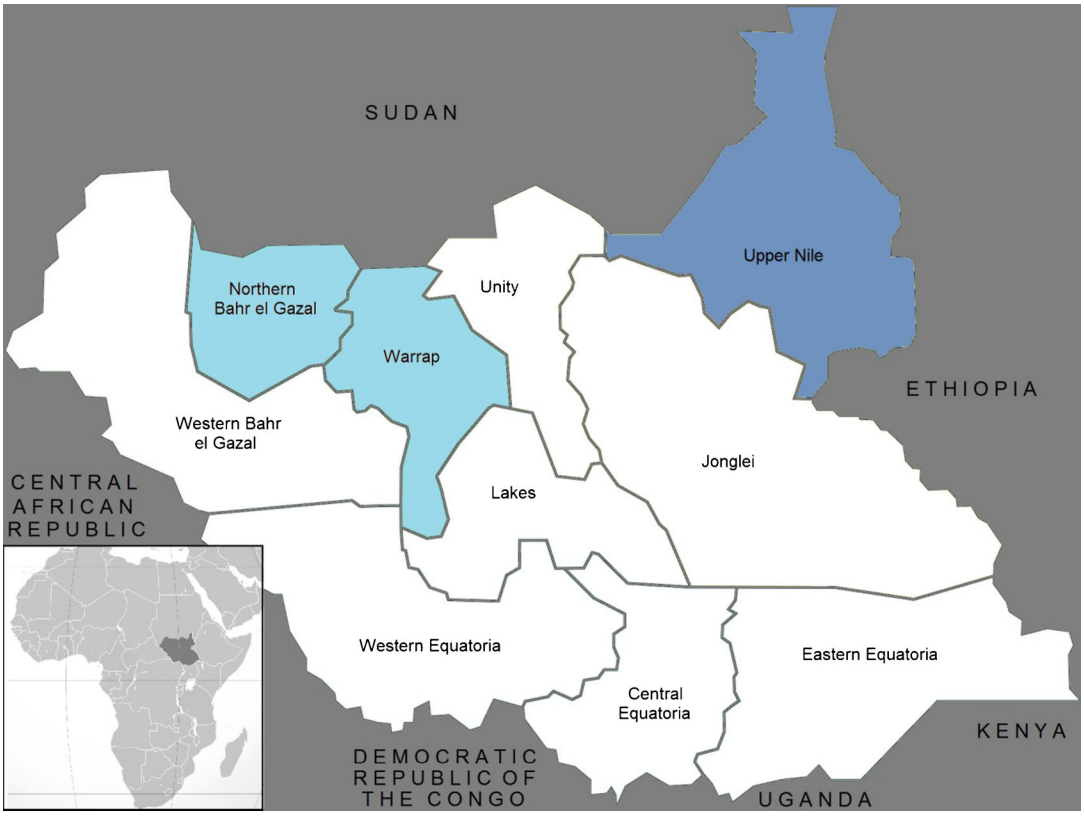
This case study is the result of regular review of ADRA's commodity tracking system throughout the project period and in-depth interviews conducted with 13 key program staff and stakeholders in South Sudan and Washington, D.C. between January and May 2012. Participants included SSHiNE senior management staff (all expatriate), and South Sudanese commodity and logistics coordinators, food warehouse managers, and food distribution supervisors employed by ADRA, Concern Worldwide, and Food for the Hungry, as well as program staff from ADRA headquarters who were involved in logistics, procurement, commodity distribution, and overall program management. Additional participants included representatives from the World Food Programme and UN Logistics Cluster in South Sudan and from USAID FFP in both South Sudan and Washington, D.C.

Interviews were conducted by a member of the Johns Hopkins Bloomberg School of Public Health (JHSPH) research team funded by a subaward to conduct operational research within SSHiNE program implementation. Informed consent was obtained orally prior to initiating all interviews. The study protocol was reviewed by the Institutional Review Board at JHSPH, which determined that this was not research on human subjects.

FINDINGS

During the course of project implementation, relations between northern and southern Sudan worsened dramatically, causing many delays and unforeseen obstacles in commodity procurement, transport, storage, management, and distribution, as illustrated in Figure 2. SSHiNE program staff and stakeholders identified 3 major challenges to program implementation: (1) procuring the required food baskets; (2) transporting the food from port to project areas; and (3) ensuring proper storage facilities.

FIGURE 1. Map of SSHiNE Program Areas



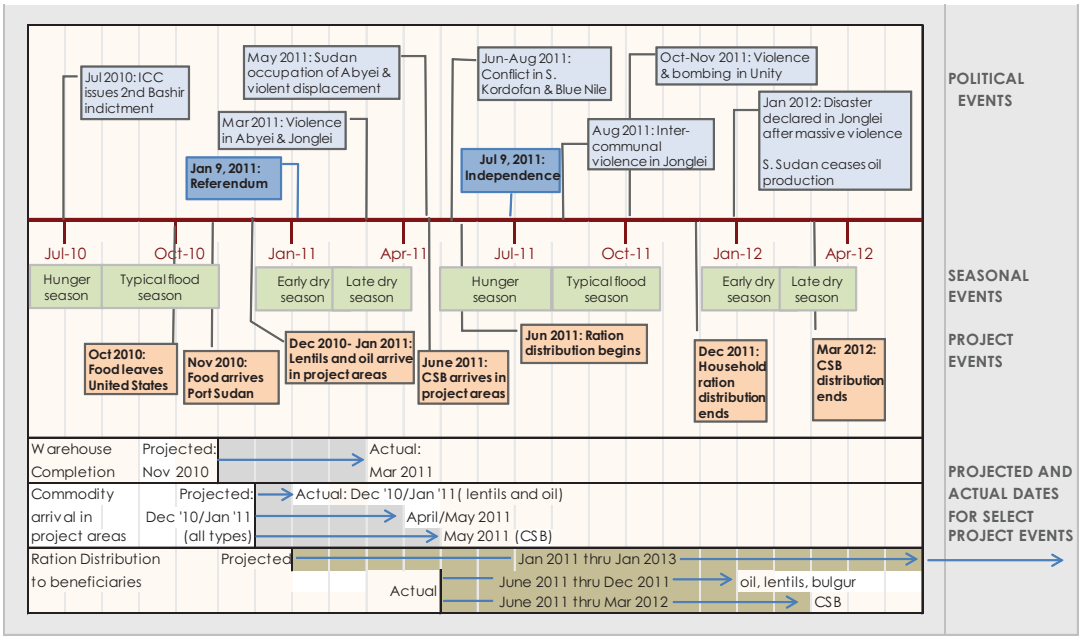
The project was initially planned for Northern Bahr el Gazal, Warrap, and Upper Nile States but was implemented only in Northern Bahr el Gazal and Warrap because of cost, logistics, timing, and security considerations.

Challenge #1: Procurement of Complete Food Basket

Since 2010, USAID has encouraged non-emergency, multiyear food assistance program implementers to adopt a preventive approach to reducing malnutrition in children under 2 years of age. This approach has been shown to be more effective in reducing the prevalence of stunting, underweight, and wasting in the context of Title II-funded programs than recuperative nutrition interventions alone.[5–6]

Core components of the Preventing Malnutrition in Children Under 2 Approach (PM2A), which was a central component of the SSHiNE program, include rations targeted to pregnant and nursing women and children under 2 years of age, which are conditional on participation in behavior change interventions; behavior change communication; and preventive and curative health and nutrition services for women and children delivered according to national protocols. In addition, the PM2A package often includes a household ration to supplement the household food supply, to prevent sharing of targeted rations, and/or to provide an incentive for participation in preventive program activities, such as clinic visits and growth monitoring. PM2A is implemented in food-insecure areas with high prevalence of stunting or underweight; it targets pregnant and breastfeeding women and children 6–23 months of age because they are the subgroups that are most vulnerable nutritionally.[7]

FIGURE 2. Timeline of Significant Events, July 2010–June 2012



Abbreviations: CSB, corn-soya blend.

Assumptions about how South Sudan would regulate genetically modified food led to critical delays in the procurement of a key food ration for vulnerable women and children.

The Issue of Genetically Modified Corn-Soya Blend

For the SSHiNE project, the PM2A ration package proposed by ADRA and approved by USAID FFP consisted of bulgur, lentils, vegetable oil, and corn-soya blend (CSB). Title II development food assistance funding requires that all donated commodities be of U.S. origin. The bulgur, lentils, and vegetable oil components of the ration were provided in-kind by the U.S. government, with the consignment for the first year of the project loaded on U.S. flagged vessels in Texas, destined for Port Sudan, in late October 2010. The CSB approved for donation by the U.S. government was a genetically modified (GM) variety and thus restricted from import into Sudan, a scenario that is not unprecedented in Sudan and is not surprising given the increasing number of nations banning the import of GM foods.[8]

At the time the SSHiNE project was awarded, the USAID mission in Sudan was to allocate a portion of the project funding as direct assistance through the USAID office in Juba to cover procurement, transport, warehousing, and distribution costs during the first year of the project for non-GM CSB. USAID representatives and authorities in South Sudan thought that in following years an independent South Sudan would loosen its regulations on GM importation and that subsequent consignments of CSB could be provided by the U.S. government in kind. However, in order for South Sudan to join the Common Market for South and Eastern Africa (COMESA), a stricter regulatory framework for GM foods was required, in alignment with regulations throughout most of East Africa.[9–10]

It was a challenge to identify a single supplier that could provide the needed quantity of non-GM CSB in the time frame required for the first year of programming. At the start of the project, ADRA identified potential suppliers of non-GM CSB in Italy and Belgium (both of which were regular suppliers of CSB to the World Food Programme). Before any contracts were awarded, the USAID mission in Juba suggested that ADRA consider procuring regionally in East Africa rather than from Europe. After multiple rounds of advertising for suppliers, a Kenyan

supplier was eventually identified. However, the commodity order was not placed until March 2011, which was 3 months after food distribution was to begin (see proposed and actual project milestones in Figure 2). Having prior arrangements with regional mills in Kenya or Tanzania might have reduced the delays in CSB procurement.

Challenge #2: Transport of Food Commodities from Port to Project Areas

Port Clearance

During many years of war, southern Sudan could viably receive goods only from its southern neighbors Uganda and Kenya. Commodities would arrive via Kenya's port city of Mombasa, with subsequent land transfer through Kenya, often by way of Uganda, to South Sudan. However, following the signing of the CPA in 2005, Port Sudan, located in northern Sudan on the Red Sea, also became a viable entry point for food commodities destined for the south, albeit not without challenges.

The USAID-commissioned 2009 Bellmon Estimation for Title II (BEST) report found that importation of food commodities through Port Sudan would be more cost-effective than through Mombasa.[11] Therefore, Port Sudan was identified as the primary seaport to receive food commodities for the SSHiNE project. This proved to be an inauspicious decision: The entire shipment of 1,650 metric tons of bulgur was held at Port Sudan for more than 3 months. During this time the Sudan Port Health Authority, Customs Authority, and Meteorology Organization conducted more than 30 tests to ascertain the appropriateness of the bulgur for human consumption before they granted clearance.

The ADRA Khartoum office, which was responsible for clearing the commodities in Sudan, engaged with USAID and local officials in efforts to get the bulgur released. Despite persistent efforts by ADRA and USAID offices in both Khartoum and Juba to negotiate release of the commodities, authorities claimed that such extensive testing was necessary because bulgur was a new import crop for the Republic of Sudan. However, history suggests that this is not the case. Between 2005 and 2009, Sudan was among the top 5 importers of bulgur worldwide.[12] Project stakeholders speculate that the customs clearance was prolonged with the sole intention of obstructing aid destined for South Sudan. Lack of clarity on import/export procedures from Sudan to South Sudan is a documented source of concern during the SSHiNE program period that forced some humanitarian organizations to use alternative supply corridors.[13] In the case of SSHiNE, the transit of bulgur at port took over 100 days, compared with about 10 days under normal conditions.

Inland Transport (Port Sudan to Project Areas)

All commodities were transferred from Port Sudan to trucks for inland transport immediately upon customs clearance. For the lentils and vegetable oil, this occurred in late November 2010, with 26 trucks setting off on the approximately 2-week journey of more than 2,300 km from Port Sudan via El Obeid to Northern Bahr el Ghazal and Warrap states. An additional 16 trucks set off on the 1-week trip (1,200 km) to Kosti, where commodities would be loaded on river barges for a 2-week trip to Upper Nile (Figure 3).

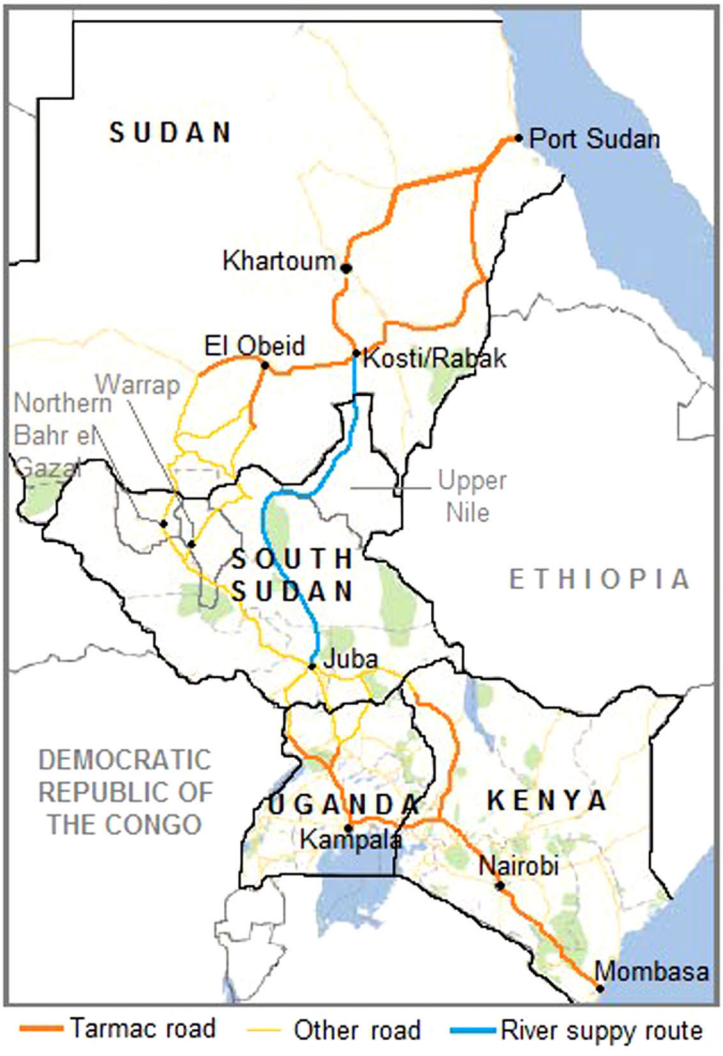
The use of a northern port to receive commodities despite political tensions meant a 3-month delay in transit to the south.

When the trucks carrying the lentils and vegetable oil arrived in project areas in December 2010, the bulgur consignment was still being held by customs agents at Port Sudan. By the time the bulgur was finally cleared through customs at Port Sudan in mid-March 2011, northern troops had begun amassing around Abyei, and the security situation along the route had deteriorated substantially. Commodity transport delays and budget shortfalls resulting from rising implementation costs led ADRA to request that project activities be conducted in only Warrap and Northern Bahr el Ghazal, 2 contiguous states, thereby cancelling implementation in the more geographically challenging Upper Nile State, which is accessible only during the dry season. The 26 trucks with bulgur destined for Warrap and Northern Bahr el Ghazal were dispatched to their end destinations in South Sudan. Since the request to cancel implementation in Upper Nile had not yet been approved, the 16 additional trucks were dispatched to Kosti, the Nile river port, pending USAID authorization to redirect the commodities to the other 2 project states.

Commodity transport delays and rising costs due to deteriorating security led to a decision to limit the focus of project activities to 2 states.

Although the vast majority of the commodities arrived intact, the overland journey from Port Sudan to Warrap and Northern Bahr el Gazal was not without obstacles. The truck convoys encountered many official and unofficial roadblocks, where soldiers or local authorities demanded bribes in the form of money or ''small gifts'' of commodities from the trucks. The roads from El Obeid to Northern Bahr el Gazal, Warrap,

FIGURE 3. Key Transport Routes From Port Sudan to SSHiNE Program Areas and Alternative Routes Through Mombasa



and Kosti are technically considered "all-weather" roads; in practice, however, there are often substantial delays due to road conditions, in particular during periods of heavy rain. There are no truck weight restrictions or stoppages of movement during or following heavy rain; therefore, many trucks become stuck, bridges are damaged, and roads are impassible during the wet season despite major road rehabilitation and demining activities.[14]

Nearly all trucks arrived at their destinations intact. One truck was missing 87 bags (4.2 metric tons) of bulgur upon arrival. Another truck, carrying 1,100 bags (55 metric tons) of bulgur, drove over a landmine after crossing into Warrap state (between Mayom and Abeinhom towns), destroying all commodities on board, severely damaging the vehicle, and injuring the driver and his assistant. The Table summarizes transit losses along with other commodity tracking information.

Unanticipated Border Closures

By the time ADRA had received formal USAID approval to forego programming in Upper Nile and redirect commodities to Warrap and Northern Bahr el Ghazal, the border between north and soon-to-be independent South Sudan had been closed due to conflict over disputed territory in the Abyei region and worsening relations over unresolved CPA issues, such as border demarcation, fees for oil export via Sudan, and citizenship rights.[15] The 405.89 metric tons of food commodities (330 metric tons of bulgur, 43.05 metric tons of lentils, and 32.84 metric tons of vegetable oil) initially destined for Upper Nile project areas remained stuck in Rabak for months while attempts were made to obtain permission from Sudanese authorities to allow food to be moved across the border. Finally, in April/May 2012, after over a year of negotiations with authorities in both Sudan and South Sudan, SSHiNE project management and USAID concluded that it would not be possible to secure the release of these stocks and instead distributed the commodities to Sudanese returnees (northern and southern) at an ADRA-operated way station in Kosti.

Challenge #3: Proper Storage Facilities

Section 403 of the 2008 Food for Peace Act mandates that adequate storage facilities be available in the host country when commodities arrive to prevent spoilage or waste.[16] Given the lack of adequate warehousing facilities in any of the project areas, ADRA ordered 20 portable warehouses from W. Giertsen HallSystem in Norway at the beginning of the project. ADRA did not have experience in South Sudan with installation of portable warehouses, and forecasting their delivery and installation was a challenge. The original timeline for importation, delivery, and construction of the warehouses prior to the arrival of commodity shipments in December 2011 was unrealistic. The materials for warehouses in Warrap and Northern Bahr el

TABLE. Commodities Procured, Stocked, and Distributed (metric tons)

	Commodity					
	Lentils	Vegetable Oil	Bulgur Wheat	Corn-Soya Blend	Total	Percentage of Total Commodity Purchased
Commodity purchased	219.00	159.45	1,641.35	340.00	2,359.80	–
Marine losses	–	0.11	11.85	–	11.96	0.5%
Transit losses	1.05	0.17	59.20	–	60.42	2.6%
Commodity stranded in Rabak	43.50	32.84	330.00	–	406.34	17.2%
Commodity received in project warehouses	174.90	126.33	1,240.30	340.00	1,881.53	79.7%
Commodity distributed	174.85	126.30	1,240.30	337.63	1,879.08	79.6%

Source: SSHiNE commodity tracking system reports.

Ghazal did not arrive at Port Mombasa, Kenya until January 2011, after the consignments of lentils and vegetable oil had already arrived in the project areas. Until the warehouse materials arrived in the project areas and warehouse construction was completed in March 2011, ADRA was forced to store the approximately 222 metric tons of lentils and vegetable oil in school buildings, containers, and guarded open spaces near project offices. This resulted in unanticipated expenses in temporary storage and quality control.

DISCUSSION

Many of the challenges described above, such as unwarranted customs delays at Port Sudan and border closures between northern and southern Sudan before independence (and between Sudan and South Sudan after), might have been anticipated, given the area's long history of logistical challenges faced by food aid programs pre-independence. Indeed, other studies have recognized that:

> South Sudan is an operational context fraught with challenges for aid agencies including lack of suitable partner organizations, high staff turnover, diversion, severe logistical constraints caused by rains and flooding in the rainy season and the near impossible task of targeting assistance.[17]

The SSHiNE program encountered additional challenges stemming from the fact that it was the first U.S.-funded development food assistance initiative in the country and that it was implemented during a unique period of instability and political transition to independence. Still, the nature of the challenges highlights the need for additional contextual analysis, contingency planning, and innovative approaches in settings undergoing political change or a transition from relief to development programming. Several aspects of Title II programming could benefit from a critical assessment:

"Emergency" Versus "Non-emergency" Designation

Re-examination of the criteria for designation of "emergency" versus "non-emergency" food assistance programs is warranted. In the face of the political uncertainty surrounding the referendum for self-determination, the end of the CPA and the transition to independence, the long-term security situation in South Sudan was at best unpredictable at the time that the request for proposals for the food assistance program was released. The situation was further complicated

Strategies used in emergencies, including donor flexibility on financing, should be adapted to transition settings where security cannot be predicted accurately.

by the lack of rain in many parts of the country in 2011, including the SSHiNE implementation area, which diminished the harvest season severely and worsened food insecurity. By the beginning of 2012, the situation had so deteriorated that it was designated a crisis (Integrated Phase Classification 3), with the potential for further deterioration to a humanitarian emergency.[13] The difficulty of making accurate long-term security predictions in many transition settings requires innovative strategies, such as the adaptation of voucher, cash transfer, and insurance schemes increasingly used in emergency settings[18–19] and greater donor flexibility for advance financing or use of prepositioned commodities.[20]

More options for procurement, shipping, and transport would make commodity pipelines more reliable in the face of security concerns or poor transportation infrastructure.

A Cost-Benefit Approach to Timely Commodity Delivery

Expanded alternatives for procurement, shipping, and transport, such as those proposed as part of U.S. government food aid reforms for fiscal year 2014, could facilitate reliable and timely commodity delivery—a central tenant of effective food assistance programming. Importation through secondary and tertiary routes, presumably involving different seaports and ports of entry into the destination country, would increase the reliability of commodity pipelines in a situation of political unrest, security concerns, and/or poor transportation infrastructure. This undoubtedly would come with additional costs. However, the SSHiNE experience suggests that the current approach of using the least costly port and inland-shipping routes may be inadequate if the situation threatens commodity losses or delays that could significantly alter the scope and impact of the program. A nuanced cost-benefit approach that allows for a more complete comparison of both the reliability and the constraints of different shipping routes, and the costs associated with each, may provide for more complete and timely delivery of commodities in complex political situations.

Local food purchase can minimize pipeline failure for commodities of U.S. origin with limited impact on U.S. domestic interests and without disrupting local markets.

Flexible Local Procurement

Greater flexibility should be considered for local and regional purchase of food commodities in settings with political instability or notable logistical challenges. Humanitarian and development practitioners have suggested that increased allowances for local and regional procurement may improve U.S. food assistance programming in several ways. Arrival delays of several months are typical when commodities are shipped from the United States, and ocean transportation on U.S.-flagged carriers is relatively costly. In contrast, food obtained via local procurement has been shown to reduce costs and improve timeliness of delivery, without disrupting local markets.[21–22]

Local procurement of fortified blend foods (FBF) is a common challenge, which in the case of the SSHiNE program resulted in delayed food distribution. Possible approaches to address this challenge at the system level include the development of planning models to better predict demand for FBFs, longer-term contracts for FBF vendors, and shipping of micronutrient premix to the region for local milling and fortification. Improving the capacity for fortification and processing in developing countries in the vicinity of emergency operations would coincide with USAID development goals as outlined in the Feed the Future Initiative.[2]

Local procurement is unlikely to become central program strategy since Title II food programming provides for the donation of U.S. agricultural commodities to meet humanitarian food needs in other countries.[23] However, local purchase could be funded through strategic public-private partnerships, and allowances could be made for this alternative in certain contexts. Critics of local purchase maintain that it would undermine the coalition of commodity groups, private voluntary organizations, and shippers that support U.S. Title II programs and ultimately result in the reduction of U.S. food assistance.[24] However, proposed food aid reforms would replace $250 million of Title II funding within development assistance to a Community Development and Resilience Fund, providing more flexibility to purchase foods locally and regionally while maintaining a significant portion of U.S. commodity purchases. Such reforms could be an effective means of minimizing the programmatic impacts of pipeline failure for commodities of U.S. origin while having limited implications for domestic interests in the United States.[25]

Contingency Planning to Account for Changing Policy

In post-conflict settings, potential changes in government policies, such as policy on imports of GM foods, require contingency planning. Given that young children are among the most nutritionally vulnerable and that preventive strategies are now the approach of choice for Title II

development programming, the availability of commodities optimized for this age group is crucial if U.S. food aid programs are to contribute to improvements in child growth.

Many fortified blended foods, such as the different varieties of CSB or wheat-soya blend (WSB) have GM components, and this creates challenges for their widespread use in food aid programs, especially U.S. food aid, where commodities generally must be of U.S. origin. Many countries have expressed reservations about or banned the import of GM foods (including commodities imported for food aid programs).[26] Planning for additional production of U.S.-origin non-GM CSB, local purchase of alternative fortified blended foods that may be more acceptable to beneficiary populations, or the use of more costly Ready-to-Use Supplementary Foods (RUSFs), which may be easier to target to intended beneficiaries, are approaches that could be used to address similar challenges in future food assistance programs.

In the SSHiNE program, critical challenges arose from uncertainty about the regulations that would be put in place post-independence and the pace at which political decisions would be made and protocols established. Inclusion of contingency plans at the proposal stage and joint development of alternative implementation strategies by implementing partners and FFP will be important to the success of U.S. food assistance programs operating in transitional contexts.

Limitations

This study focuses on lessons learned from the South Sudan experience (based on the opinions of the interviewees) that have implications for food aid in similar situations. Including an analysis of organizational capacity and decision-making of the implementing organizations would have yielded a more comprehensive assessment of this specific situation, but such findings would not be generalizable. In addition, distinguishing between external, contextual factors and internal, organizational factors is sometimes challenging. For example, identifying and retaining qualified field staff is a major issue for NGO programs in South Sudan and an external factor that clearly influenced organizational capacity and decision making. At the same time, internal factors, such as the compensation package offered by the implementing organization may have exacerbated recruitment difficulties in an already challenging environment.

CONCLUSION

Title II food assistance programs aim to meet humanitarian food needs and promote food security among vulnerable populations in foreign countries. The nature of the settings in which many of these programs operate is such that the challenges faced in commodity transport are frequent, extreme, and unpredictable. More flexibility in the procurement, transport, and management of commodities could increase the effectiveness of Title II food assistance programs. The proposed food aid reforms for fiscal year 2014, which will enhance the ability of NGOs to adapt implementation strategies to the local context, are an important step toward more responsive programming.

The U.S. government and international organizations continue to be committed to providing emergency and development assistance in conflict and disaster-affected contexts. Critical to the success of both short-term humanitarian response efforts and longer-term development initiatives is the ability of NGOs to anticipate challenges and implement contingency plans with rapid approval by donors. This flexibility, along with real-time adaptation strategies to address contextual challenges, local procurement of commodities, and attention to the need for acceptable and affordable supplementary foods, will contribute to improved delivery of U.S. food assistance abroad.

Contingency plans and alternative implementation strategies should be developed at the program proposal stage.

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ORIGINAL ARTICLE

Use of modern contraception increases when more methods become available: analysis of evidence from 1982–2009

John Ross,[a] John Stover[b]

International data over 27 years show that as each additional contraceptive method became available to most of the population, overall modern contraceptive use rose. But in 2009 only 3.5 methods, on average, were available to at least half the population in surveyed countries. Family planning programs should strive to provide widespread access to a range of methods.

ABSTRACT

Objective: To examine how much contraceptive use increases as additional methods are made available to populations.

Methods: We used data estimating contraceptive use from representative national surveys and data estimating method availability from special surveys to make comparisons for 6 modern contraceptive methods, in each of 6 years: 1982, 1989, 1994, 1999, 2004, and 2009. To estimate method availability, we used various method accessibility rules governing different proportions of the total population (ranging from 20% to 80%) that must have access to a method in order for it to qualify as ''available.''

Results: Contraceptive use is greater when more methods are available to a large portion of the population, both cross-sectionally and over time. The addition of 1 method available to at least half the population correlates with an increase of 4–8 percentage points in total use of the 6 modern methods, for example, from 40% to 44% or 48%. A consistent pattern emerges for the relationship of contraceptive use and choice among multiple methods.

Conclusions: Use of contraception may be increased by extending the availability of current methods, by improving features of current methods, or by introducing new methods. A wider choice of methods also improves the ability to meet the individual needs of women and couples. Although the method mix has been improving over time, current availability is far from ideal; in 2009, only about 3.5 methods, on average, were available to at least half of the population in the 113 countries included in our analysis.

BACKGROUND

Use of modern contraception is prevalent across much of the developing world, but countries vary widely in total use and in the number and range of method choices available to potential users. For example, in sub-Saharan Africa the IUD is hardly available anywhere, but pills and injectables are generally available in the east and south. On the other hand, the IUD is commonly available in the Middle East. Female sterilization is not easily accessible in either region, but it is present in much of Latin America and in parts of Asia.[1]

No single method serves the needs of every subgroup in a population. The one-method programs established by some ministries of health exclude many people interested in using family planning and tend to result in low proportions of the population using contraception. In such cases, the addition of another modern method to a program's method mix can raise total use. Adding more methods helps up to a point, until diminishing returns set in. All this depends partly upon which methods are offered, but the very presence of more choices can assist users whose needs could not be met by any single method.

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Expanding the contraceptive method mix has been shown to improve continuation rates.

Analyses from 1971 onward have helped to demonstrate this relationship. For example, a Taiwan analysis showed a considerable rise in the duration of contraceptive use when family planning programs began offering multiple methods, estimating that the addition of one method would increase total contraceptive use by about 12 percentage points (from 30% to 42%).[2] A simulation study demonstrated the limitations of any one method, noting that the usual discontinuation rate for a method would leave users with no alternative protection for their remaining reproductive years, except to have multiple abortions.[3] A cross-national analysis found a systematic correlation between access to methods and their use.[4] A recent study using detailed cluster-level data and service availability assessments from the Demographic and Health Surveys (DHS) demonstrated that improvements in family planning supply have a positive effect on contraceptive prevalence.[5]

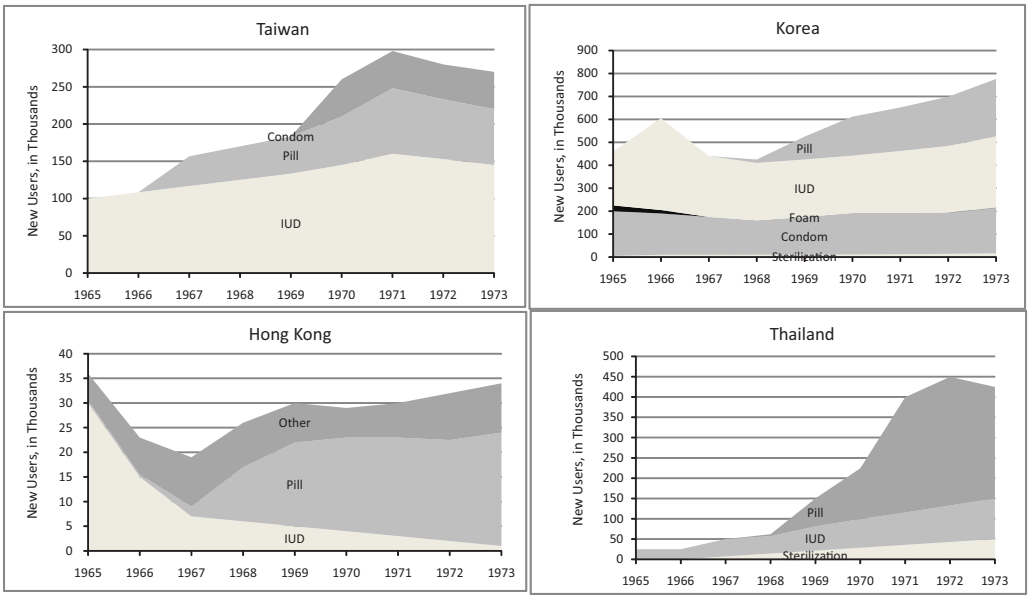
A striking example of the adoption of newly available contraceptive methods comes from the early experience of the first large-scale family planning programs in 4 Asian countries, during the advent of the IUD and pill (Figure 1). In these 4 countries, contraceptive use rose sharply after each new method emerged from the research stage and was made accessible to the population at large.[6] Counter-examples, at least in part, include India and Pakistan, where the method mixes changed more erratically during the turbulent years of the late 1960s and 1970s.

The objective of this article is to extend previous research by examining how much contraceptive use increases as additional methods become available to whole populations, using national survey data and estimates of the degree of method availability.

DATA SOURCES

Nationally representative data from the DHS series[7] and from other national surveys compiled by the United Nations (UN) Population Division[8] provide time trends for the modern contraceptive prevalence rate (MCPR), which includes use of

FIGURE 1. Impact of Adding New Contraceptive Methods on the Number of Users, 1965–1973



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male and female sterilization, IUDs, pills, injectables, implants, and condoms. We also refer to the contraceptive prevalence rate (CPR), which includes the previously mentioned modern methods, plus traditional methods, such as rhythm and withdrawal.

We obtained estimates of the MCPR for each country for each of the 6 years examined in our research from the surveys included in the UN compilation. Where surveys did not fall exactly on 1 of the 6 dates included in our analysis, we estimated the MCPR by interpolation between surveys bracketing the desired date. Where pairs of surveys were unavailable for interpolation, we set the MCPR value for the earliest years in question to the first available survey, and for years after the last available survey, we set the MCPR value to the latest available survey. This approach simplified the analysis and avoided questionable extrapolations before or after a survey estimate, although some error may be involved. The national surveys with MCPR data cover nearly every developing country, many with multiple surveys for various dates.

The number of contraceptive methods available in national family planning programs comes from the ''Family Planning Effort (FPE) Index,'' a score measuring the strength of national family planning programs on 4 dimensions (policies, services, evaluation, and method access) compiled through detailed questionnaires administered periodically over the past 4 decades.[1] For the method access dimension, 10–15 expert observers from various professions and agencies in each country rate the extent to which the population has access to IUDs, pills, female sterilization, male sterilization, condoms, and, since 2004, injectables. (The addition of injectables to the questionnaire in 2004 could increase the number of available methods in our analysis for some countries, depending on the percentage judged to have access to the method.) Their responses are averaged after inspection for extreme outliers; as a further check, standard deviations are examined for each item in each country.

We used FPE Index data on method access from 1982, 1989, 1994, 1999, 2004, and 2009 to determine the number of methods available. Over all survey rounds, the FPE Index included 113 countries one or more times, drawn from all developing-country regions. In the survey rounds up to and including 1999, respondents rated ''the percentage of couples of reproductive age who have ready and easy access to each method.'' From 1999 to 2009, the FPE Index used a simpler questionnaire by asking respondents to rate the percentage of couples with access to each method on a scale from 1 to 10, which was then converted to the percentage estimate. (The 1999 index used both sets of ratings to compare the 2 methodologies.)

METHODS

We considered a method to be ''available'' in the national family planning program if FPE Index survey respondents judged that a certain percentage (ranging from 20% to 80%) of the population had access to it. We used alternative accessibility rules of at least 20%, 40%, 50%, 60%, 70%, and 80% of the population having access to a method, in order to test the consistency of the relationships. These values were chosen somewhat arbitrarily but give a broad range and permit a check on the robustness of results when ''availability'' is defined differently. If we define method availability as low as a mere 20% of the population having access to the method, many more countries will be included in the analysis than if 60% of the population must have access to the method. The consistency of the conclusions under multiple assumptions is important since standard significance tests are not applicable, due to the complexities of sampling error in the original surveys compounded with survey errors in the access information for the 6 methods.

Table 1 shows how a more lenient accessibility rule increases the number of countries included in the analysis. It gives the number of countries with at least 1 available method qualifying under each accessibility rule, in each survey. The more severe the rule, the fewer the countries that qualify, as shown by the diminishing numbers in each column. In the 1982 survey, for example, 65 countries made 1 or more methods available, as defined by the lenient accessibility rule of only 20% of the population having access to the method, while only 26 countries met the stricter rule of 80% accessibility. An individual country therefore might have 4 methods, each accessible to 20% of the population, but only 1 method accessible to 80% of the population.

The other variable, the percentage of married/in-union women using modern methods (MCPR), is entirely separate, both empirically

TABLE 1. Number of Countries With At Least 1 Available Contraceptive Method Included in the Analysis, by Method Accessibility Rule and Survey Year

	Survey Year					
Accessibility Rule[a]	1982	1989	1994	1999	2004	2009
20%	65	81	91	86	83	81
40%	46	68	84	85	83	80
50%	45	64	78	82	81	80
60%	38	57	71	79	77	80
70%	35	51	65	74	65	67
80%	26	40	59	53	41	39

[a] Per judgment of respondents to the Family Planning Effort Index survey that a certain percentage of the population in their country had access to a particular contraceptive method.

Use of modern contraception, and the number of available methods from which people can choose, have both been increasing over time.

and conceptually. Accessibility/availability and use are quite different; a method may be widely available but little used. An example is the condom, which is generally available but used by only a small proportion of couples. (Another example is the traditional method of withdrawal, which is universally available but used only selectively.)

We conducted 4 different analyses using these data:

1. **Time trends:** to compare the trends in the mean MCPR and the mean number of available methods from 1982 through 2009
2. **Variability:** to compare variation in the MCPR with the average number of available methods, repeated for each year
3. **Correlational:** to examine the correlation across countries for the MCPR and the average number of available methods, repeated for each year
4. **Fixed effects regression:** to measure the relationship between method availability and MCPR, controlling for within-country variation

Modern contraceptive use has increased over time with each additional method made available to the population.

Although these 4 approaches explore the relationship of method availability and contraceptive use, they do not control for such confounding influences as the social setting, the health structure, or the particular method mix at each level of contraceptive use.

RESULTS

Using these 4 approaches, we compare results for the relationship between contraceptive availability and use, selected from the 6 years and the 6 alternative contraceptive accessibility rules.

Time Trends Analysis

First, the number of methods available and the MCPR have both been increasing over time (Figure 2). The average MCPR rose from 23% to 37% between 1982 and 2009, represented by the dashed line in Figure 2. The solid lines show the average number of methods available among all surveyed countries in each year (right-hand axis), by the different accessibility rules. The more restrictive accessibility definitions (from 40% to 80%) produce lower estimates of the number of methods available. Nevertheless, each trend line for the accessibility rules from 20% through 60% rises in the analysis. The rise is more gradual (lower slope) as the accessibility percentage increases, and it is even negative at 80%. That is, the slopes rise less with more stringent levels of accessibility, probably because some saturation effect occurs once methods are fairly widely accessible.

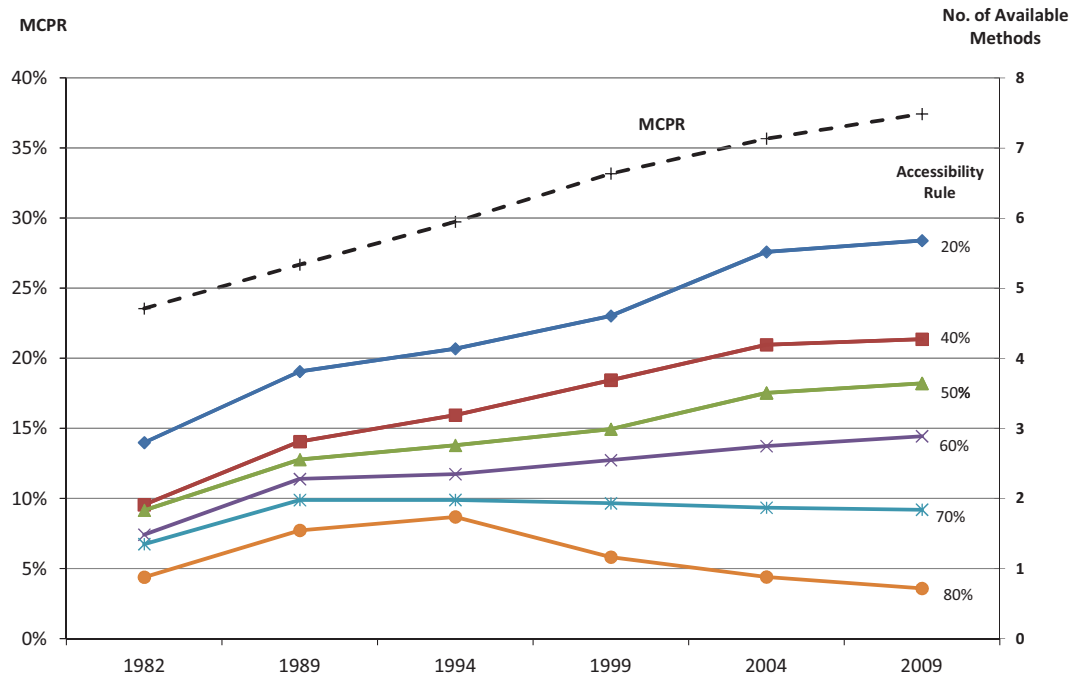
Variability Analysis

Second, cross-sectional correlations between the MCPR and the number of available methods for the 113 surveyed countries also show the MCPR-Availability correspondence. Figure 3 uses 2009 data to show the distribution of MCPR values for countries according to the average number of available methods according to the 50% accessibility rule. The least squares line gives an R^2 value of 0.37 and a slope of 9.8, suggesting that 1 additional method raises the MCPR by nearly 10 percentage points in the latest survey round of FPE method accessibility scores.

The earlier survey years have somewhat smaller slopes of about 7 to 8 points (Table 2). Still, the patterns are again striking. Using the 50% accessibility rule for every year, once more the R^2 values start high and descend (until 2009), while the slopes start low and rise.

There appears to be a large variation in the MCPR, especially at 3, 4, and 5 available methods (Figure 3), but this is partly because more countries fall into those categories, creating more data points. Nevertheless, the MCPR can vary due to a number of determinants that are not included in the analysis. For example, traditional

FIGURE 2. MCPR and Number of Available Methods, by Various Accessibility Rules, 1982–2009



Abbreviation: MCPR, modern contraceptive prevalence rate.

contraceptive methods compete with and can reduce use of modern methods, as can extended breastfeeding. Also, where fertility rates are high, the proportion of women who are currently pregnant or postpartum is larger than in countries where fertility rates are lower, and total contraceptive use is lower. In addition, the uptake of available methods can be depressed where conservative attitudes prevail, as in some sub-Saharan African countries. Finally, the social setting matters; favorable socio-economic factors (such as education, income, urbanization) tend to raise contraceptive use levels, apart from the number of available methods. Much research over the years finds that the social setting and national family programs share credit in increasing contraceptive use levels: each has an independent effect, and both can act in concert.[9]

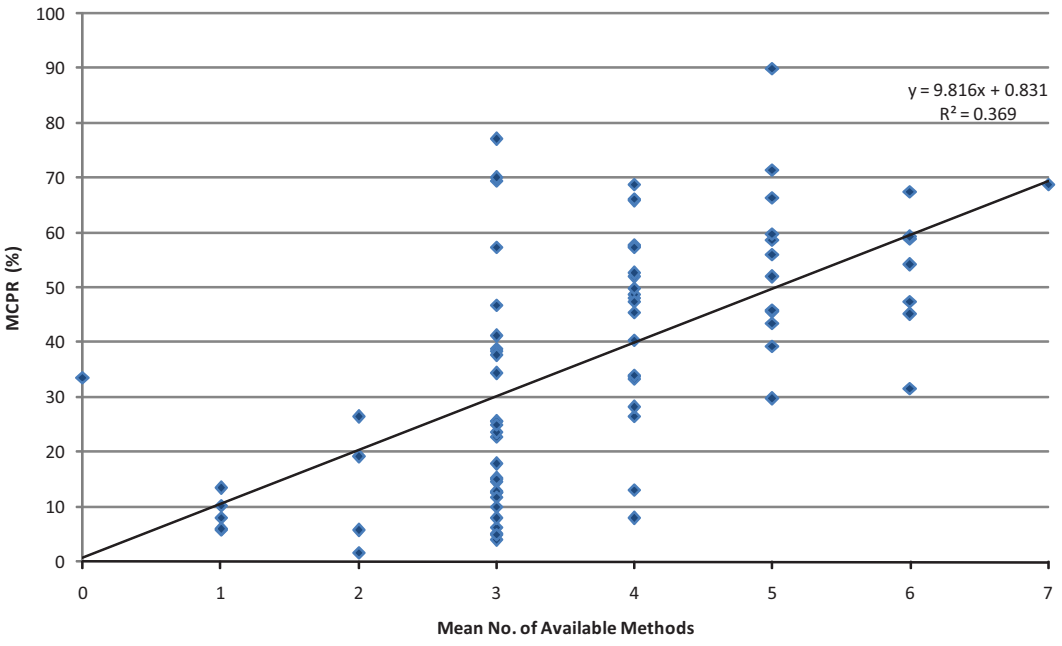
Correlational Analysis

Third, correlations show the rise in the MCPR with the increasing average number of available methods for each year. Figure 4 shows the relationships for the 40%, 50%, and 60% accessibility rules. The 6 points on each line represent the 6 survey years, from 1982 at the lower left to 2009 at the upper right, and each point shows the relationship between the average number of available methods and the average MCPR. For example, the 50% line in the middle starts low, with an average of slightly more than 2 methods available in 1982, rising regularly until in 2009, it exceeded 3.5 methods. Over the same time period, the average MCPR rose from just above 23% to about 37%. Regardless of the accessibility rule used, the association is always positive, and both values rise regularly over the years, in a linear pattern. (Note that the 40% line is positioned at the far right of the graph since it yielded the largest number of available methods.)

Regardless of the method accessibility rule used, modern contraceptive use always rises with each additional method made available.

We repeated this analysis for all accessibility rules, from 20% through 80% (Table 3). The R^2 values start high (at the least stringent accessibility rule) and decrease, while the slopes start low and increase (until the strict 80% rule,

FIGURE 3. Relationship Between MCPR for 113 Surveyed Countries and Number of Available Methods, According to the 50% Accessibility Rule, 2009



Abbreviation: MCPR, modern contraceptive prevalence rate.

Solid line represents the least squares line across all countries.

TABLE 2. Relationship Between Mean MCPR and Mean Number of Available Methods According to the 50% Method Accessibility Rule, by Survey Year

Survey Year	R^2	Slope
1982	0.66	7.2
1989	0.58	7.5
1994	0.43	7.4
1999	0.34	8.7
2004	0.22	8.0
2009	0.37	9.8

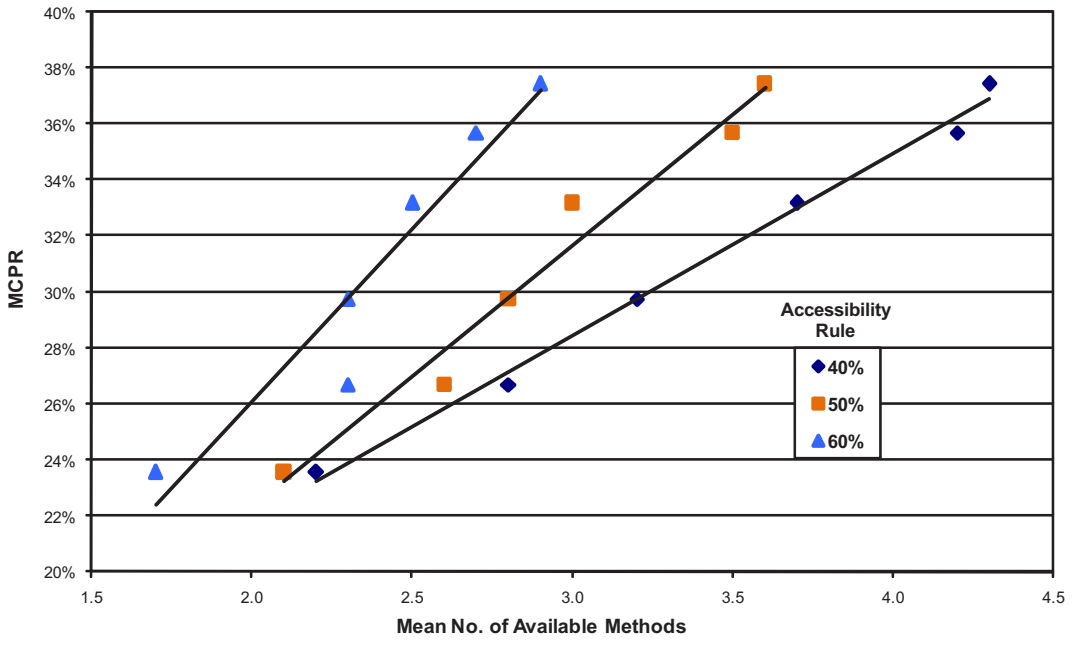
Abbreviation: MCPR, modern contraceptive prevalence rate.

for which fewer countries qualified). The essential point is that different accessibility rules, through 60%, show very consistent MCPR results, which fade only at the extremes of 70% and 80%. The increase in the MCPR ranges from 5–11 percentage points (indicated by the slope of the line) for each additional method made available. By the 50% accessibility rule, an increase of 1 new method is accompanied by nearly an 8 percentage point rise in the MCPR.

Fixed Effects Regression Analysis

Fourth, a ''fixed effects'' analysis measures the MCPR-Availability relationship with a control for within-country variation; this also corrects for the unequal numbers of data points among countries (some countries reported method access in all 6 survey years while others reported method access in fewer surveys; the average was 4.7 years of reporting).

FIGURE 4. Relationship Between MCPR and the Number of Available Methods, by Accessibility Rule, 1982–2009



Abbreviation: MCPR, modern contraceptive prevalence rate.

The 6 points on each line represent the 6 survey years, starting with 1982 at the lower left of each line and moving up to the right for 1989, 1994, 1999, 2004, and 2009.

TABLE 3. Relationship Between Mean MCPR and Mean Number of Available Methods, by Method Accessibility Rule, 1982–2009

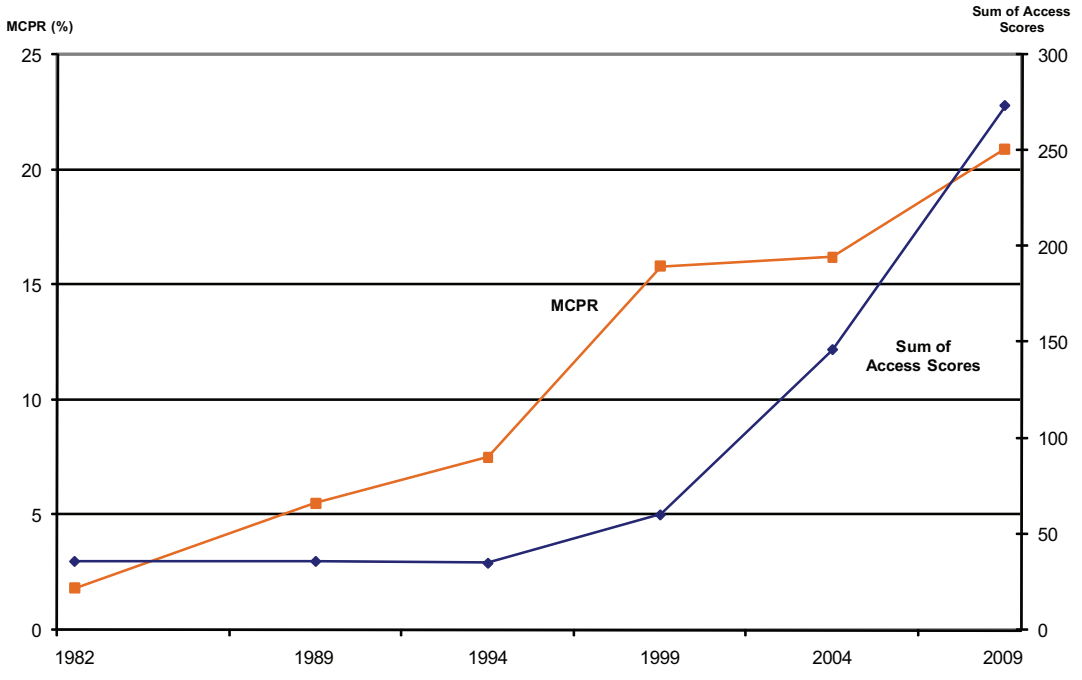
Accessibility Rule	R^2	Slope
20%	0.97	4.9
40%	0.98	5.9
50%	0.96	7.9
60%	0.88	10.9
70%	0.25	11.2
80%	0.16	(5.3)

Abbreviation: MCPR, modern contraceptive prevalence rate.

The fixed effects analysis finds the MCPR-Availability relationship within each country and then accounts for variations across the countries. As an example of the within-country relationship, Figure 5 uses the 6 surveys in Ethiopia. Over the 27 years from 1982 to 2009, availability improved steadily (indicated by the "sum of access scores" line), and the MCPR among married/in-union women rose from under 5% to 23%.

In this analysis, we summed the accessibility ratings for male and female sterilization, pills, IUDs, condoms, and injectables to create a total access score as a continuous variable. The resulting data set had 447 observations for 96 countries. The analysis, conducted with Stata 9.0, found that the access score is highly significant ($P<.01$, $t_{350}=11.9$) and indicated an increase in MCPR of 4.5 percentage points (95% confidence interval=3.8–5.3) with each additional method made available.

FIGURE 5. Relationship Between MCPR and Sum of Access Scores for All Modern Methods, Ethiopia, 1982–2009



Abbreviation: MCPR, modern contraceptive prevalence rate.

DISCUSSION

Using multiple approaches to analyze the data, we found a consistently close correspondence between the number of available methods and the MCPR. The first 3 analyses showed that the addition of a new method raises the MCPR by approximately 7–8 percentage points, for example, from 40% to 47% or 48%, and somewhat more so in the latest survey data from 2009. The fixed effects regression in the fourth analysis confirms a significant relationship between method availability and MCPR, although the impact is at the low end of the range produced by the other approaches.

A broader method mix helps meet the individual and varied family planning needs of women and couples.

As noted above, our analyses cannot separate the effects of method availability on the MCPR from the ways by which increasing demand for contraception may encourage a program to make new methods available. But it does support the finding that greater availability of a number of contraceptive methods produces increases in MCPR over time.

The correspondence between method availability and the MCPR appears both over time (1982–2009) and cross-sectionally each year among the set of countries included in these analyses. This correspondence also exists under a variety of accessibility rules governing how much of the population must have access to a method for it to be regarded as an additional available method in the mix. (In the past, the 50% accessibility rule alone has been used to determine which methods, and which combination of methods, were available in most countries.[10]) And finally, the correspondence exists when the sum of contraceptive prevalence for all modern methods is the access measure.

As a country adds more methods to its offerings, it broadens the method mix, reducing "method skew,"[11] which is a measure of the narrowness of the mix. A country that depends

on only 1 or 2 prominent methods has more skew than a country with 3 or more methods. A broader offering gives options to more women and couples in the population with their differing needs. This tends to raise the MCPR.

The present results appear sufficiently strong to suggest that entirely new methods of family planning can increase modern contraceptive use in countries that make them widely available, giving more options to meet the needs of individuals. The impact may be less for new methods that are minor variations of existing methods, such as a new 6-month injectable compared with the existing 1- and 3-month injectables, although such new methods may improve contraceptive continuation rates.

In addition, a method that dramatically expands availability through lower cost or other advantages may be expected to have significant impact on contraceptive use, even if the method itself is not new. One example includes contraceptive implants, which are already growing in popularity and benefiting from markedly reduced pricing.[12] Further, community-based distribution of some methods may be extended, for example by *Sayana® Press* (formerly known as depo-subQ provera 104™ in Uniject™)—a new subcutaneous formulation of *Depo-Provera®* packaged in the Uniject prefilled injection system.[13]

The results of this analysis are not limited to inventions of new methods; they also suggest that increases in the MCPR may occur by simply widening geographic access to more of the existing methods. Patterns across 64 countries show that those with higher contraceptive prevalence tend to have a broader mix of methods.[1] Currently, our analysis indicates that only about 3.5 methods are available, on average, to 50% of the population, and less than 2 methods are available by the 70% accessibility rule.

This analysis also implies a significant effect of stockouts on contraceptive use. To the extent that stockouts of a method are equivalent to lack of availability as measured here, the effect on MCPR may be similar. One study showed an association between the CPR and the average availability of methods at service delivery points on the day of survey across 7 countries.[14] The results show an effect roughly equivalent to a 5–6 point increase in CPR associated with availability of 1 additional method, not far from the 7–8 point increase emerging from 3 of our analyses.

There is the possibility of a dual influence between access to a method and popular interest in it. When it becomes clear that a method such as the injectable in eastern and southern Africa is taking off, programmatic efforts may be made to extend its availability to more clinics and to remote areas of the country. Conversely, if a new method is offered in selected areas but few women find it attractive or continue using it, efforts may slacken to supply it throughout the country or to seek budgetary funds to purchase large quantities of it.

Limitations

Limitations to our analyses provide leads for further research. The results here do not control for possible confounding influences, such as education and income levels, the degree of urbanization, or differences in health systems. Similarly, programs that are intrinsically stronger may improve overall access in a variety of ways other than by adding to the number of available methods. These and other determinants of the MCPR and the CPR can be explored in future research, apart from the number of methods that are reasonably accessible to the population.

Introduction of new methods or improvements to features of existing methods may increase use of modern contraception.

In addition, a more detailed focus on individual contraceptives would be of interest, to show the uptake of the pill alone, the IUD, or the injectable after each method becomes generally accessible in most of the country. Some of this research might be pursued by grouping methods into resupply and long-acting categories.

Which particular methods comprise the method mix as the mix changes over time is a topic of interest. A mix made up primarily of resupply methods may produce a lower MCPR than a mix that contains more long-acting methods, because of the inferior continuation rates of resupply methods compared with long-acting methods.

On average, only 3.5 methods are available to half of the population in surveyed countries.

Within-country studies to compare differential responses to varying levels of accessibility by province would control some confounding variables that are present in cross-country research. Further, there are interesting questions about the factors that affect program managers' perceptions of which new methods promise widespread programmatic use, in light of their apparent advantages and disadvantages.

CONCLUSION

Our research indicates that there is significant potential to increase contraceptive use by

expanding access to existing methods and by making new or modified methods widely available. Although the method mix has been improving over time, as of 2009 only about 3.5 methods, on average, were available to half of the population in the 113 surveyed countries included here. Improving method availability would simultaneously expand benefits to individual women and to couples through wider contraceptive choice.

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ORIGINAL ARTICLE

Improving performance of Zambia Defence Force antiretroviral therapy providers: evaluation of a standards-based approach

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A detailed standards-based performance approach modestly improved providers' performance and facility readiness to offer antiretroviral therapy. The approach included mutually reinforcing activities: (1) training, (2) supportive supervision, (3) assessments of service quality, and (4) facility-based action plans.

ABSTRACT

Background: The Zambia Defence Force (ZDF) has applied the Standards-Based Management and Recognition (SBM-R®) approach, which uses detailed performance standards, at some health facilities to improve HIV-related services offered to military personnel and surrounding civilian communities. This study examines the effectiveness of the SBM-R approach in improving facility readiness and provider performance at ZDF facilities.

Methods: We collected data on facility readiness and provider performance before and after the 2010–2012 intervention at 4 intervention sites selected for their relatively poor performance and 4 comparison sites. Assessors observed whether each facility met 16 readiness standards and whether providers met 9 performance standards during consultations with 354 returning antiretroviral therapy (ART) clients. We then calculated the percentages of criteria achieved for each readiness and performance standard and conducted bivariate and multivariate analyses of provider performance data.

Results: Facilities' ART readiness scores exceeded 80% before the intervention at both intervention and comparison sites. At endline, scores improved on 4 facility readiness standards in the intervention group but on only 1 standard in the comparison group. Multivariate analysis found that the overall provider performance score increased significantly in the intervention group (from 58% to 84%; $P<.01$) but not in the comparison group (from 62% to 70%). The before-and-after improvement in scores was significantly greater among intervention sites than among comparison sites for 2 standards—initial assessment of the client's condition and nutrition counseling.

Conclusion: The standards-based approach, which involved intensive and mutually reinforcing intervention activities, showed modest improvements in some aspects of providers' performance during ART consultations. Further research is needed to determine whether improvements in provider performance affect client outcomes such as adherence to ART.

BACKGROUND

The incidence of HIV infection in Zambia has declined by more than one-fifth since 2000.[1] Still, the prevalence of infection among adults remains high—an estimated 12.5% in 2011.[2] Zambia has rapidly scaled up HIV counseling, testing, treatment, and care over the past 10 years. Government policy provides for free antiretroviral therapy (ART) for anyone with a CD4+ cell count below 350/mm^3. Estimates of ART coverage vary from 72% to 90% of the more than 420,000 adults in need of treatment in 2011.[1,3] However, rising demand for ART and other HIV-related services has stressed the capacity of available infrastructure, drug supplies, trained staff, and management and support systems.[4] Improvements in service delivery are also needed to ensure

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that ART is started early and to promote adherence to lifelong treatment, which is crucial to maximizing the prevention and treatment benefits of antiretroviral (ARVs) drugs and minimizing the development of drug resistance.[3]

The need for more and better ART services holds true for military as well as civilian populations in Zambia. The demographic makeup of the military and conditions of deployment have led to higher HIV prevalence in the armed forces than in general populations across sub-Saharan Africa.[5–6] In Zambia, a 2004 seroprevalence study found that HIV prevalence among Zambia Defence Force (ZDF) personnel was 29%,[7] compared with a national prevalence of 16% at that time.[8] The ZDF established an HIV/AIDS program focused on prevention in 1993 and since has steadily expanded HIV-related services.[9] These efforts have had a positive impact on a range of indicators. For example, the proportion of ZDF personnel ever-tested for HIV rose from just 18% in 2004 to 84% in 2011,[10] compared with 23% of the general population who had been voluntarily tested for HIV and received results as of 2009.[11] The number of ZDF health facilities offering comprehensive and integrated HIV/AIDS services increased from just 5 in 2006 to 28 in 2013, with a concomitant rise in the number of clients served.

More recently, the ZDF has made the quality of HIV-related services a priority.[7] To that end, the ZDF began introducing Jhpiego's Standards-Based Management and Recognition (SBM-R®) approach at some hospitals and clinics in 2006. This quality improvement initiative has the potential to influence care beyond the military population because ZDF's 54 facilities serve surrounding communities as well as military personnel and their families: civilians make up four-fifths of the clients seen at ZDF facilities. The military health system accounts for 16% of health services in Zambia.[12] Thus, successful interventions at ZDF facilities can serve as models for the Ministry of Health (MOH) system, with which it is deeply integrated.

Successful interventions at ZDF facilities can serve as models for the MOH system.

The SBM-R Approach: 4 Steps

The SBM-R approach to quality improvement uses a set of detailed standards to guide health care workers and measure progress in service delivery.[13] It looks not only at provider performance, but also at the functioning of management, drug procurement, and other systems.

1. The first of 4 steps in the SBM-R process (Figure 1) is to establish evidence-based and locally relevant standards that define the desired level of performance in a service delivery area. Each performance standard is divided into a series of specific tasks, known as verification criteria for purposes of assessment. In Zambia, for example, the performance standard for assessing ART clients for adverse reactions includes 6 verification criteria: inquiring about sleeping problems, inquiring about nausea and vomiting, inquiring about yellow eyes, inquiring about shortness of breath, offering reassurance, and treating side effects appropriately. Because SBM-R performance standards are so detailed, they function as job aids that help individual providers improve their performance. Primarily, however, they serve as assessment tools that enable facilities to measure compliance with accepted standards of care.
2. The second step in SBM-R is to implement the performance standards at each facility, under the direction of a team of managers and providers. With outside support, the facility team conducts a baseline assessment of services, using a mix of direct observations, structured interviews, and record review to assess whether each verification criterion is met. Team members follow a step-wise

FIGURE 1. The 4 Steps of the Standards-Based Management and Recognition (SBM-R) Approach

Box. Using SBM-R to Develop Action Plans

SBM-R team members:

- Analyze assessment findings
  ↓
- Identify weaknesses in service delivery
  ↓
- Determine the causes
  ↓
- Develop low-cost, local solutions
  ↓
- Implement an action plan to address performance gaps

process that leads to an action plan (see box). They take a relatively simple approach to analyzing each gap identified, using root cause analysis, and look within the facility for realistic solutions that can be implemented with existing personnel and resources. Only if that fails does the team seek outside assistance, which in Zambia meant going up the chain of command to the unit commander. It takes about 1 week for the facility team to conduct the baseline assessment, analyze the findings, and create an action plan. Implementing different portions of the action plan can take a few months to a year, depending on how complicated they are and whether outside assistance is needed.

3. The third step in SBM-R is to monitor the facility's progress toward meeting the standards by periodically repeating the performance assessment and working to address remaining performance gaps.
4. When sufficient progress is made, the facility reaches the fourth and final step in the SBM-R process: recognizing and rewarding achievements.

Although SBM-R shares some elements with other approaches to quality improvement, SBM-R is designed to have certain advantages in low-resource settings:[14]

- It focuses more on practical solutions and less on analysis.
- It helps transfer learning because assessment tools can be used as job aids and for self-monitoring.
- It achieves quick and consistent results.
- It motivates health workers, because they actively participate in the process as members of the facility team overseeing SBM-R.
- It keeps costs low and is easier to scale up because it requires little additional manpower, mobilizes existing resources, and focuses on low-cost solutions.

Measuring the impact of quality improvement interventions on health care has proved difficult. This may explain the lack of rigorous studies, despite the many projects that have tested quality improvement interventions in developing countries. Recent reviews of the literature have concluded that the evidence base for quality improvement remains weak, although some studies suggest a positive impact.[15–16] Rawlins and colleagues found that the SBM-R approach improved the performance of reproductive, maternal, and child health services in Malawi.[17] However, SBM-R has not been widely applied to HIV treatment, and there are no evaluations of its effectiveness for ART services. Nor has there been an assessment of the suitability of the approach for military health systems. SBM-R may be more challenging in a military setting because of its collaborative team approach, which requires facility staff at every level to work together to identify and address performance gaps. This style conflicts with that of the military's hierarchical command structure.

METHODS

Study Purposes

This study evaluates the effectiveness of the SBM-R approach in improving ART services in a military setting. We examine 2 components of quality. The first, facility readiness, assesses whether adequate infrastructure, supplies and equipment, and management and support systems are in place to support good-quality services. The second, provider performance, assesses whether providers meet standards for good-quality care during their interactions with returning ART clients.

Study Design and Sample

This study employed a quasi-experimental design that collected data at 2 points in time from intervention and comparison sites. Baseline data were collected from August 10 through October 21, 2010, taking 1 to 4 days per facility. The intervention launched on September 15, 2010

and continued up to and beyond the second round of data collection. At 2 intervention sites, we collected endline data from March 13 through April 13, 2012, after the SBM-R intervention had been in place for 18 to 19 months. Because of an administrative transition, we had to collect endline data earlier at the other 2 intervention sites and the 4 comparison sites; these data were collected from November 29 through December 8, 2011. At that point, the SBM-R intervention had been in place for 15 months.

Of the ZDF's 54 facilities, 16 had already implemented SBM-R and so were excluded from the study. The ZDF selected 4 of the remaining 38 facilities as intervention sites, based on their sufficient caseload and need for improvement. We selected 4 non-intervention sites for comparison; they were matched as closely as possible with intervention sites on ZDF branch, number of beds, and size of catchment population. It proved impossible to match sites based on ART service volume. Also, we did not match comparison sites with intervention sites on performance or perceived need for improvement. The 8 health facilities in the sample represent all 3 branches of the ZDF: they include 2 Zambian Air Force facilities, 2 Zambian National Service facilities, and 4 Zambian Army facilities.

We invited all health care providers responsible for delivering ART services to participate in the study, and all of them agreed. A total of 21 providers were interviewed at baseline and 28 at endline—1 to 5 providers at each facility in each round. Due to problems assigning unique ID numbers to providers during data collection, we cannot be certain whether the same or different individuals were interviewed in each round of data collection, nor can we link providers with the consultations observed. We took steps in the statistical analysis to account for potential non-independence in the outcome measures.

Clients who had already started ART and were returning for a follow-up visit were eligible to participate in the study. Providers asked clients' permission to have their consultations observed. Assessors observed every client who came for an ART follow-up consultation with a participating provider during their facility visits. The same procedure was followed at intervention and comparison sites. The goal was to observe 25 consultations at each facility, but that was not always possible. The number of clients observed per facility during each round ranged from 21 to 27, with 3 exceptions (9, 13, and 16 observations). In the end the procedure yielded a convenience sample of 354 clients who were returning for ART follow-up visits—81 clients at the baseline and 81 clients at the endline at intervention sites and 94 clients at the baseline and 98 clients at the endline at the comparison sites. It is unlikely that the same clients were observed during both rounds of data collection, but we do not know for certain. We did not ask clients whether they were military personnel, but it is reasonable to assume that the majority were civilians, given that civilians make up four-fifths of all clients seen at ZDF facilities. Service data suggest that the clients observed represent about one-fifth of the facilities' ART client population.

The Intervention

The SBM-R intervention at ZDF sites was designed to improve 2 service areas: ART and the prevention of mother-to-child transmission (PMTCT) of HIV. While this article focuses on the impact on ART services, simultaneous efforts were proceeding at intervention sites to improve PMTCT services. We are analyzing and presenting those findings separately.

The MOH, Jhpiego, ZDF, and the University Teaching Hospital adapted, for Zambia, the ART standards developed in South Africa; they were based on international best practices as summarized in World Health Organization (WHO) guidelines. The standards were first implemented in 2006 at the start of the larger SBM-R project in Zambia. They were further refined to fit the Zambian context in 2010, which resulted in shorter tools that were easier to implement.

Next, 2 staff members from each intervention site attended a 3-day workshop on SBM-R, after which ZDF and Jhpiego staff visited the facilities to launch the intervention. During a 3-day visit to each facility, they oriented managers to SBM-R, introduced service providers to the tools and desired outcomes, and coached providers. A team of 4 to 7 staff members were assembled at each facility to lead the SBM-R process for both ART and PMTCT. Each team included the facility in-charge and 3 to 6 service providers who played diverse roles at the facility; they included clinical officers, nurses, medical assistants, and pharmacy technicians. Teams' membership changed over the course of the study, as some individuals were transferred to other ZDF facilities or left for temporary deployments. Colleagues and supervisors oriented their replacements to SBM-R. However, ART providers at intervention sites did

not change: all of them remained in place from baseline to endline. We do not know whether the comparison sites experienced any provider turnover.

During the initial site visit, ZDF and Jhpiego staff worked with the facility team to conduct a formal assessment of ART and PMTCT services, using the SBM-R tools to identify strengths and weaknesses in provider performance and support systems. They systematically examined conditions at the facility, observed interactions with clients, and recorded whether or not each verification criterion was met. Afterwards, the team reviewed the results and used a ''Why Tree'' approach to determine the causes of each problem: they asked why a problem occurred and then turned the answer into another ''why'' question. They repeated this process until satisfied that they had found the root cause of the problem.

The Action Plan

Following the site visit review, the team developed a detailed action plan to improve service quality. The plan listed each problem, along with a solution, the person responsible, and an expected date of completion. The SBM-R teams and managers at all of the facilities considered implementing the action plan to be the most important part of SBM-R and worked at it daily. Some action points were handled entirely at the facility level: for example, to facilitate collaboration, a manager compiled a list of local organizations providing health services. Sometimes outside assistance was needed: for example, a team found that the poor treatment of Military Medical Assistants (MMAs) contributed to inadequate staffing. MMAs are recruited from the ranks of the ZDF to fill shortages in the number of health workers; they are initially trained to provide basic services, such as bandaging wounds and taking vital signs, but may eventually gain a skill set equivalent to that of an enrolled nurse. Officers viewed MMAs as casual workers and frequently ordered them to perform non-health-related tasks. The SBM-R teams raised the issue with unit commanders and ZDF headquarters, who fully committed the MMAs to health care.

Shortly after and in response to the baseline SBM-R assessments, providers received 5 days of onsite ART training to strengthen knowledge of the standards and improve clinical skills. The training was competency-based and included lectures, role plays, and opportunities to practice with clients. ZDF and Jhpiego also provided needed supplies and equipment to facilities, such as gloves and blood pressure cuffs.

To encourage facility teams to continue pursuing problems, ZDF and Jhpiego arranged 3-day supportive supervision visits to each facility approximately twice a year. During these visits, a team of 2 or 3 supervisors observed consultations and mentored staff. Supervisors came mostly from the ZDF's largest referral hospital and had extensive experience with SBM-R assessments. Supervisors coached individual providers on meeting ART standards. Also, they met with the facility team to review and, if necessary, revise the SBM-R action plan. None of the teams at the intervention sites took the initiative to repeat the SBM-R performance assessments by themselves during the course of the study. Instead, they focused on implementing the action plan and measured their progress by how many action points they had resolved. The study did not last long enough for any of the sites to reach the last step in the SBM-R cycle, recognition and rewards.

Data Collection

We collected data from 2 sources: observations of the facility's readiness to offer ART services and observations of ART follow-up consultations. The units of analysis are the facility and the individual consultation, respectively. The baseline and the endline employed the same data collection tools (see supplementary materials).

Facility Readiness Observations: At each site, assessors completed a facility observation instrument based on SBM-R tools. It covered operations that directly support ART services, such as the supply of antiretroviral drugs, and general support systems that are essential to delivering good-quality health care services of all kinds, such as adequate staffing. As shown in Table 1, the instrument covered 8 standards for ART readiness and 8 standards for general readiness; together they included 95 verification criteria. Assessors marked each one as observed or not observed for the facility as a whole.

Observation of Consultations: Before the consultation, assessors asked returning clients about their age, education, number of prior ART visits, and duration of therapy. During the consultation, assessors completed an observation checklist that

TABLE 1. Facility Readiness Standards, Standards-Based Management and Recognition

ART Readiness Standards	No. of Verification Criteria	General Readiness Standards	No. of Verification Criteria
ART drug requisition: system for reordering drugs is properly managed	5	Staffing: sufficient staff are available for daily operations	3
ART drug storage: drugs are properly stored, tracked, and issued	9	Infrastructure: staff and client comfort and safety are assured	6
Pharmacist counseling: information on ART drugs is offered to clients	9	Supplies: sufficient stocks of critical supplies are available	3
Individual monitoring plan: plan is developed with client to monitor adherence and toxicities	8	Management systems: referral, scheduling, communication, and evaluation systems are working	7
Checking adherence: follow-up visits reinforce adherence to treatment, answer questions, and dispense drugs	11	Waste disposal: waste is handled and disposed of properly	5
Access to lab tests: clients' access to required laboratory tests is ensured	2	Client records: client files are kept confidential and are readily available	5
Blood drawing: infection prevention and other guidelines are followed	9	Health information system: timely collection, analysis, and reporting	5
Transport of blood samples: proper collection and transport to laboratory	3	Performance improvement: ongoing implementation of performance improvement activities	5
Maximum possible ART facility readiness score	**56**	**Maximum possible general facility readiness score**	**39**

Abbreviation: ART, antiretroviral therapy.

included 9 performance standards for ART follow-up consultations (Table 2). Assessors noted whether the provider performed each of 48 verification criteria.

Training of Data Collectors

To ensure the quality of the data, we recruited assessors who had experience with field work and trained them on the purpose of this study, the data collection tools, recruitment procedures, consent process, data collection, and ethical issues. Two assessors were hired to collect the data for each round of data collection. All 4 were physicians with considerable experience in ART services. They were third-party staff from the MOH who did not work at the ZDF facilities being assessed. ZDF personnel assisted only in helping the assessors gain admission to the military sites.

Ethical Considerations

The University of Zambia Biomedical Research Ethics Committee and the Johns Hopkins Bloomberg School of Public Health Institutional Review Board approved this study. Observations and interviews took place in private, and providers and clients gave their informed consent.

Data Analysis

For facility readiness, we calculated the percentage of verification criteria achieved for each readiness standard and overall scores for ART readiness and general readiness (Table 1). For provider performance, we calculated the percentage of verification criteria achieved for each performance standard as well as an overall score for provider's performance during ART follow-up consultations (Table 2).

We conducted both bivariate and multivariate analyses on provider performance data.

TABLE 2. Performance Standards for Provision of ART Services, Standards-Based Management and Recognition

Standard	No. of Verification Criteria	Content
Initial assessment of patient's condition	6	Greetings, registration, ask about patient well-being, review medical history
Assessment of opportunistic infections	3	Rule out pneumocystis pneumonia, cryptococcal meningitis, and tuberculosis
Assessment of adverse reactions	6	Inquire about sleeping problems, nausea, yellow eyes, shortness of breath, etc., and offer reassurance
Assessment of potential drug interactions	3	Ask about new medications, document concurrent medications, check for drug interactions
General health assessment	3	Inquire about contraception, pregnancy, alcohol and recreational drug use, depression; perform targeted physical exam; request and review laboratory tests
Verification of how patient is taking ART and cotrimoxazole	9	Check medication schedule, supplies, missed doses; reinforce adherence; address patient concerns
Addressing identified issues, as needed	8	Manage infections, adverse reactions, laboratory abnormalities; make referrals for social services
Concluding the consultation	5	Address patient questions, plan return visit, complete registers and applicable forms
Nutrition counseling	5	Discuss diet, food preparation, boiling drinking water, hand washing
Maximum possible ART follow-up score	**48**	

Abbreviation: ART, antiretroviral therapy.

(Small sample sizes did not permit further analysis of data collected on facility readiness.) The initial bivariate analysis calculates the gain or decline in percentage achieved scores from baseline to endline separately for the intervention and comparison groups. We used a t-test to detect whether the change from baseline to endline within each group was statistically significant. Further, a multivariate analysis estimates the effect of time on performance outcomes by intervention group status. In the multivariate models, the outcome variable is the number of achieved or performed verification criteria in a standard. Generalized linear regression (GLM) models with Poisson distribution and log link function were used. The GLM model with Poisson distribution was selected after comparing different models, including negative binomial regression, using the Akaike information criterion. The total number of verification criteria is included in the model as an offset term. In addition to adjusting for ZDF branch, the independent variables included the time point (baseline or endline), the evaluation group (intervention or comparison), and the interaction of these terms. The interaction term compares the change in percentage achieved scores (both magnitude and direction) from baseline to endline between intervention and comparison groups. The models also included a cluster-adjusted robust variance estimator, as data obtained within 1 facility are correlated.[18] All analyses were performed using Stata 12.0 (College Station, TX).

RESULTS

Provider Characteristics

A total of 21 ART service providers were interviewed at baseline (12 in the intervention group and 9 in the comparison group), and 28 were interviewed at endline (14 each in the

Facilities' ART readiness scores were relatively high at the baseline, exceeding 80% in both comparison and intervention groups.

intervention and comparison groups). About half were nurses or nurse-midwives (47.6% at baseline and 53.6% at endline). The rest were clinical officers (42.9% at baseline and 28.6% at endline) and Medical Military Assistants (MMAs) (9.5% at baseline and 14.3% at endline). There was no significant difference between comparison and intervention sites in the distribution of provider types or in providers' age, sex, experience in the ZDF, or years at the facility.

On average, ART providers were 36.0 years old (standard deviation [SD]=7.9) at baseline and 35.5 years old (SD=6.6) at endline. Over half were male (57.1% at baseline and 67.9% at endline). On average, they had served as a ZDF health care provider for around a decade (mean 9.8 years, SD=8.7, at baseline, and mean 10.1 years, SD=6.7, at endline). On average, ART providers had worked at the same facility for 4.6 years (SD=5.80) at baseline and 6.1 years (SD=4.81) at endline. At baseline, 88.9% of providers in the intervention group and 91.7% in the comparison group reported receiving training on ART in the preceding year (P=.83). Since training was part of the intervention, at endline all providers in the intervention group reported recent training on ART.

Client Characteristics

All clients observed were returning ART clients. At baseline, most of the clients observed were male (Table 3). At endline, however, the comparison group was mostly female, while the intervention group remained mostly male; the difference was significant (P<.01). The mean age of ART clients was in the mid-30s. Over 80% of ART clients had completed at least primary schooling. About 11% of female ART clients at baseline were pregnant, compared with about 8% at endline.

Over four-fifths of all clients observed were making at least their third ART follow-up visit. At baseline, a significantly higher proportion of ART clients in the comparison group than the intervention group were making their first ART follow-up visit (8.8% versus 1.2%; P<.05). There were no significant differences at endline. Most clients had received ART for at least 2 years. The proportion that had received ART for 3 years or longer increased from 17% at baseline to 36% at endline in the comparison group and from 18% to 43% in the intervention group, reflecting the scale up of ART over time.

Facility Readiness

ART readiness scores were relatively high at baseline, exceeding 80% in both comparison and intervention groups (Table 4). The ART readiness score declined slightly in the intervention group, but this was primarily because of a sharp drop on a single standard, pharmacy counseling, which fell by 18 percentage points. Scores improved on 4 of 8 standards, and the 2 standards with the lowest baseline scores showed gains of 25 percentage points: checking adherence with treatment at follow-up and proper collection and transport of blood samples to the laboratory. There was no room for improvement on another 2 standards, which had scored 100% at the baseline.

In the comparison group, the overall ART readiness score declined from 84% at baseline to 78% at endline. Only 1 standard (checking adherence with treatment) showed improvement, while performance declined on 5 other standards and remained constant on 2. The declines exceeded 15 percentage points for 3 standards: ART counseling by pharmacists, individual monitoring plans, and blood drawing.

General readiness scores in both the comparison and intervention groups were relatively high at baseline, exceeding 85%, and increased slightly by endline. For most standards, the change was limited. In the intervention group, however, scores rose 10 percentage points for performance improvement and fell 10 percentage points for client records. In the comparison group, the score for the health information system dropped by 15 percentage points.

Provider Performance

At baseline, provider performance was comparable in the 2 study groups (overall ART scores of 62% at the comparison sites and 58% at the intervention sites). During the study, however, the performance of providers during ART follow-up consultations improved more in the intervention group than the comparison group (Figure 2). The overall ART score rose from 58% to 84% in the intervention group. This was a significant increase in both the bivariate (P<.001) and multivariate analyses (P<.01). In the comparison groups, the overall ART score increased, but not as much (from 62% to 70%). This change was significant in the bivariate analysis (P<.001) but not the multivariate analysis.

Some intervention facilities made more progress than others. Three sites had similar overall ART scores at baseline, ranging from 51.3% to

TABLE 3. Percentage Distribution of ART Client Characteristics in Zambia Defence Force Facilities, by Round of Data Collection and Study Group

Characteristics	Baseline			Endline		
	Comparison Group (n=94)	Intervention Group (n=81)	*P* value	Comparison Group (n=98)	Intervention Group (n=81)	*P* value
Sex						
Male	60.9	50.6	.18[a]	32.7	53.1	.006[a]
Female	39.1	49.4		67.4	46.9	
Age, in years						
Mean (SD)	37.3 (8.3)	33.0 (9.4)	.001[b]	34.3 (11.9)	35.8 (10.8)	.39[b]
Educational attainment						
Some primary	12.1	6.3	.14[a]	19.0	17.3	.01[a]
Primary or some secondary	52.8	45.0		57.9	39.5	
Secondary or higher education	35.2	48.8		23.2	43.2	
Pregnant						
(among women only)						
Yes	10.8	10.8	.99[a]	7.9	8.3	.94[a]
No	89.2	89.2		92.1	91.7	
First or later ART follow-up visit						
First	8.8	1.2	.03[a]	7.0	10.0	.78[a]
Second	3.3	8.6		10.5	10.0	
Third or more	87.9	90.1		82.6	80.0	
Duration of ART						
≤1 year	42.7	38.5	.85[a]	36.6	33.8	.63[a]
2 years	40.7	43.6		28.0	23.8	
3+ years	16.5	18.0		35.5	42.5	

Abbreviations: ART, antiretroviral therapy; SD, standard deviation.
P values ≤ .05 were considered statistically significant.
[a] *P* value from χ^2 test
[b] *P* value from *t*-test

53.4%, and improved to 80.6% to 97.8% at endline. The fourth site had a higher baseline score (68.9%) but showed no progress on the overall ART score (69.5%), although there were marked gains on certain standards.

Scores on 8 of 9 ART performance standards increased significantly in the intervention group, according to the bivariate analysis (Table 5). (The score for concluding the consultation was already at 100% at baseline.) Gains on 6 standards remained significant in the multivariate analysis. Gains exceeded 40 percentage points for 3 standards: assessment of potential drug interactions, addressing identified issues as needed, and

Gains exceeded 40 percentage points for 3 performance standards that had some of the lowest baseline scores.

TABLE 4. Facility Readiness to Offer Good-Quality Services: Percentage of Verification Criteria Achieved, by Data Collection Round and Study Group, Among Zambia Defence Force Health Facilities

Readiness Standards[a] (No. of Criteria)	Comparison Group (n=4)			Intervention Group (n=4)		
	Baseline	Endline	Change (% points)	Baseline	Endline	Change (% points)
ART facility readiness						
ART drug requisition (5)	100.0	100.0	0	100.0	100.0	0
ART drug storage (9)	92.6	85.2	−7.4	85.2	91.7	+6.5
Pharmacist counseling (8)	85.1	63.2	−19.9	92.6	75.0	−17.6
Individual monitoring plans (8)	81.3	65.2	−16.1	75.0	78.1	+3.1
Checking adherence (12)	63.2	73.2	+10.0	51.5	76.7	+25.2
Access to lab tests (2)	75.0	66.7	−8.3	100.0	100.0	0
Blood drawing (9)	96.4	77.8	−18.6	100.0	94.4	−5.6
Transport of blood samples (3)	50.0	50.0	0	62.5	87.5	+25.0
Total ART readiness score (56)	*83.7*	*78.2*	*−5.5*	*88.5*	*86.2*	*−2.3*
General facility readiness						
Staffing (3)	91.7	100.0	+8.3	100.0	91.7	−8.3
Infrastructure (6)	75.0	79.2	+4.2	86.7	95.8	+9.1
Supplies (3)	83.3	88.9	+5.6	100.0	100.0	0
Management systems (7)	100.0	96.4	−3.6	95.8	100.0	+4.2
Waste disposal (5)	80.0	73.8	−6.2	95.0	90.0	+5.0
Client records (5)	95.0	100.0	+5.0	95.0	85.0	−10.0
Health information system (5)	95.0	80.0	−15.0	95.0	100.0	+5.0
Performance improvement (5)	80.0	85.0	+5.0	90.0	100.0	+10.0
Total general readiness score (39)	*85.8*	*93.9*	*+8.1*	*92.5*	*95.1*	*+3.4*

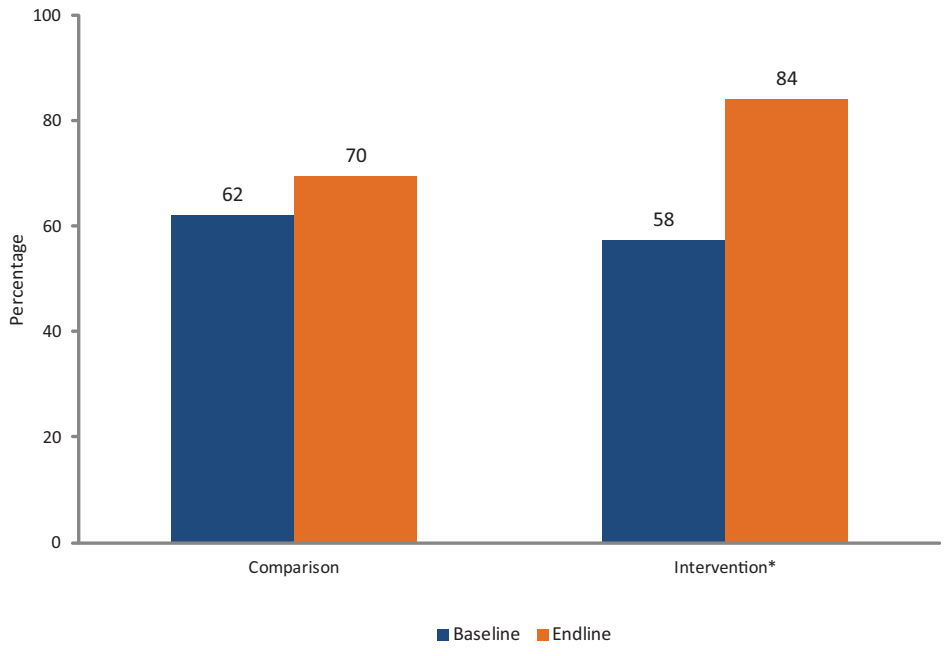
Abbreviation: ART, antiretroviral therapy.
The number of criteria observed at each of the 4 facilities was summed for each readiness standard. This sum was calculated as a percentage of the total number of criteria for each standard, multiplied by 4 to include all 4 facilities.
[a] Missing values removed from numerator and denominator. N/A values recoded as missing.

nutrition counseling. These standards were among those with the lowest baseline scores.

In contrast, in the comparison group performance improved significantly on only 4 standards, according to the bivariate analysis, and fell significantly on 2 standards. In the multivariate analysis 2 gains (verification of how the patient takes ART and assessing potential drug interactions) and 1 decline (assessment of adverse reactions) remained significant. Gains in the comparison group were consistently smaller than those in the intervention group.

The interaction term in the multivariate analysis was significant for 2 standards: the initial assessment of patient's condition ($P<.001$) and nutrition counseling ($P<.001$). This indicates that there was a statistically significant difference in the amount of change over time experienced in the comparison and intervention groups. The interaction term was

FIGURE 2. Provider Performance: Percentage of Verification Criteria Achieved



n = 175 at baseline; 179 at endline.

*$P<.001$

not significant for the other 7 performance standards or the overall ART score.

DISCUSSION

Effectiveness of Intervention

The intervention addressed 2 components of quality: facility readiness and provider performance. SBM-R had a positive, but limited, impact on facility readiness. ZDF facilities were already well-prepared to offer ART services at baseline, in part because of a capacity-building initiative that has worked aggressively since 2007 to strengthen logistics management and the health supply system at all 54 ZDF facilities.[19] During the course of the SBM-R intervention, however, intervention sites made greater progress on certain readiness standards, such as transport of blood samples, than comparison sites. This may be due to the emphasis that SBM-R teams placed on readiness and management issues in their action plans.

The findings suggest that the SBM-R intervention likely also contributed tqo an improvement in provider performance. Over the course of the intervention, facilities implementing SBM-R experienced substantial gains on every ART performance standard that had room for improvement. In contrast, comparison sites experienced smaller gains on fewer standards, and performance on some standards declined significantly. Notably, there was great improvement at intervention sites in many areas prioritized by the WHO's Global Health Sector Strategy on HIV/AIDS,[20] including nutrition and co-infections and co-morbidities. Not all intervention facilities experienced the same gains. Informal feedback from program managers suggests that variations in leadership ability, management skills, and understanding of SBM-R among facility managers and SBM-R team members are the primary reasons for the variation in effects.

Not all intervention facilities experienced the same gains. Managers said that this was due to differences in leadership, management, and understanding of SBM-R.

TABLE 5. ART Performance: Results of Bivariate and Multivariate Analyses of Percentage of ART Verification Criteria Achieved, by Data Collection Round and Study Condition, Among Zambia Defence Force Health Facilities

	Bivariate Analysis					
	% Achieved		Change From Baseline to Endline Within Group		Multivariate Analysis[a]	
ART Performance Standard and Study Condition	Baseline (n=175)	Endline (n=179)	% Points	*P* value	Adjusted *P* value for Change Within Group	*P* value for Interaction
Initial assessment of patient's condition						
Comparison	90.1	92.3	+2.2	.08	.67	.001
Intervention	79.6	99.1	+19.5	.001	.001	
Check for signs of opportunistic infections						
Comparison	86.2	67.8	−18.4	.001	.28	.13
Intervention	65.2	82.9	+17.7	.001	.33	
Assessment of adverse reactions						
Comparison	61.2	50.0	−11.2	.005	.001	.10
Intervention	44.0	78.9	+34.9	.001	.22	
Assessment of potential drug interactions						
Comparison	44.2	79.8	+35.6	.001	.001	.26
Intervention	33.1	80.7	+47.6	.001	.001	
General health assessment						
Comparison	68.3	83.5	+15.2	.001	.25	.29
Intervention	62.3	93.0	+30.7	.001	.001	
Verify how patient is taking ART						
Comparison	57.0	84.6	+27.6	.001	.05	.93
Intervention	59.8	91.0	+31.2	.001	.02	
Addressing identified issues						
Comparison	32.9	60.1	+27.2	.001	.20	.93
Intervention	45.0	85.4	+40.4	.001	.001	
Concluding the consultation						
Comparison	100.0	98.7	−1.3	.06	.17	.83
Intervention	100.0	98.1	−1.9	.03	.25	
Nutrition counseling						
Comparison	4.6	2.0	−2.6	.09	.41	.001
Intervention	1.6	42.3	+40.7	.001	.001	
Overall ART score						
Comparison	62.2	69.6	+7.4	.001	.13	.09
Intervention	57.5	84.2	+26.7	.001	.008	

Abbreviation: ART, antiretroviral therapy.

P values ≤ .05 were considered statistically significant.

[a] Results from generalized linear regression with Poisson distribution adjusted for Zambia Defence Force branch and clustering within a facility.

Implementing SBM-R

The largest expenditures associated with SBM-R were for facility action plans to improve services, notably the purchase of supplies and equipment and ART training. In contrast, costs for SBM-R training were modest because of the onsite group training model used. Assessing the cost of supervision is difficult, because it cuts across multiple practice areas. Providers found that they needed to spend more time with clients to meet SBM-R standards, which could eventually drive up costs as ART caseloads increase. ART follow-up visits with a counselor and a clinician averaged 20 minutes if clients were not experiencing problems and longer if providers had to address an opportunistic infection or other issue.

SBM-R proved to be effective in a military setting despite fears that low-ranking providers would not feel comfortable playing an active role on facility teams. In practice, they viewed themselves as health professionals and acted accordingly. The command-driven nature of the military actually benefited from the intervention, as high-ranking officers took a personal interest in its success. The vocal support of the commanding officer at each site was instrumental in encouraging lower-ranking health workers to embrace quality improvement efforts.

Can lessons learned in a military setting apply to the broader population? In Zambia the military and civilian health systems are closely coordinated. ZDF facilities serve a largely civilian clientele and rely on the MOH for ART guidelines, in-service training workshops, and district supervision teams. Many of the lessons learned from the SBM-R initiative at ZDF facilities can be and are being readily applied to improve the quality of civilian health care. In fact, MOH facilities began introducing SBM-R in 2012. The intervention may work well in settings where the facility in-charge and other authorities give vocal support to it, and where leaders encourage all providers to embrace the quality improvement efforts.

Study Strengths and Limitations

The study has 2 key strengths. First is the quasi-experimental design, with baseline and endline measures as well as intervention and comparison sites. This design protects against several threats to validity, including history effects (external events that may affect outcomes), maturation (natural improvements over time due to experience), and testing effects (earlier measurements affecting later measurements).[21]

Second, the study relied on direct observations of actual performance conducted by experienced health professionals without ties to the ZDF, using detailed and comprehensive tools that reflect international best practices for low-resource settings and Zambian service guidelines. This approach offers a more objective and reliable assessment of provider performance than interviews, self-reports, simulations, chart reviews, or role plays, which may be biased or reflect idealized situations.[22]

However, interpretation of the findings is subject to certain limitations:

- Participating facilities and individuals were not randomly assigned to the intervention and comparison arms of the study; this is difficult to accomplish in practice.[21]
- Intervention facilities were deliberately selected for SBM-R because they were considered to be in greater need of quality improvement. Therefore, the facility sample may not be representative of all ZDF facilities. The results also are not generalizable to facilities that are not associated with the ZDF.
- The small sample size limited the power of the analysis to identify significant differences between intervention and comparison groups.
- Because providers try harder when under observation (the Hawthorne effect), observations likely overstate providers' usual performance on the job.
- Although inter-observer reliability was checked during training, it was not assessed during the study.
- Sixteen ZDF facilities had already implemented SBM-R prior to this study. It is possible that some of their providers, who were trained on SBM-R, transferred into comparison sites before or during this study. This would tend to narrow differences between the intervention and comparison groups. However, there was no transfer of ART providers out of intervention sites during the study.
- There was a significant difference in client distribution by sex between the intervention and comparison groups at endline.

Direction for Further Research

This study assessed the short-term impact of the intervention: endline data were collected 15 to 18

months after SBM-R was launched. This was not enough time for intervention facilities to reach the recognition and rewards stage of SBM-R, which has the potential to enhance and sustain impact on provider performance and retention.[13] Nor was this long enough to assess the sustainability of the SBM-R process. Additional research is needed to assess the impact of the complete SBM-R intervention over longer time periods.

With the scale up of ART across Africa, follow-up services for ART clients are becoming an increasingly important part of the continuum of care for HIV.[23] While a complex web of personal, social, and structural factors influences clients' adherence to ART regimens, studies in Zambia[24–25] and elsewhere[26] suggest that quality of care and dissatisfaction with and distrust of health services can play an important role. Quality improvement evaluations need to move beyond provider performance to encompass outcomes such as client perceptions, adherence, and service utilization. This will require collecting both service data and client interview data. Understanding the perspectives of the providers is also important as they are key actors in quality improvement efforts.

CONCLUSION

ZDF has been rolling out SBM-R to 4 facilities a year, and the MOH has also begun to introduce the approach at its facilities.

ZDF facilities serve an increasing number of clients who are on ART for the long term. A quality improvement initiative that included multiple reinforcing activities—provider training, supportive supervision, detailed performance standards, repeated assessments of service quality, and facility action plans—showed modest improvements in provider performance during consultations with returning ART clients. ZDF has been rolling out SBM-R to 4 facilities a year, and the MOH also has begun to introduce the approach at its facilities, which suggests that the intervention is replicable in both military and civilian settings.

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ORIGINAL ARTICLE

Islam and family planning: changing perceptions of health care providers and medical faculty in Pakistan

Ali Mohammad Mir,[a] Gul Rashida Shaikh[a]

Training health care providers and medical college faculty about the supportive nature of Islam toward family planning principles addressed their misconceptions and enhanced their level of comfort in providing family planning services and teaching the subject.

ABSTRACT

A USAID-sponsored family planning project called ''FALAH'' (Family Advancement for Life and Health), implemented in 20 districts of Pakistan, aimed to lower unmet need for family planning by improving access to services. To enhance the quality of care offered by the public health system, the FALAH project trained 10,534 facility-based health care providers, managers, and medical college faculty members to offer client-centered family planning services, which included a module to explain the Islamic viewpoint on family planning developed through an iterative process involving religious scholars and public health experts. At the end of the FALAH project, we conducted a situation analysis of health facilities including interviews with providers to measure family planning knowledge of trained and untrained providers; interviewed faculty to obtain their feedback about the training module; and measured changes in women's contraceptive use through baseline and endline surveys. Trained providers had a better understanding of family planning concepts than untrained providers. In addition, discussions with trained providers indicated that the training module on Islam and family planning helped them to become advocates for family planning. Faculty indicated that the module enhanced their confidence about the topic of family planning and Islam, making it easier to introduce and discuss the issue with their students. Over the 3.5-year project period, which included several components in addition to the training activity, we found an overall increase of 9 percentage points in contraceptive prevalence in the project implementation districts—from 29% to 38%. The Islam and family planning module has now been included in the teaching program of major public-sector medical universities and the Regional Training Institutes of the Population Welfare Department. Other countries with sizeable Muslim populations and low contraceptive prevalence could benefit from this module.

BACKGROUND

Pakistan, currently the sixth most populous country in the world, was a pioneer in the region by launching a full-fledged family planning program in the mid-1960s. However, the program has achieved only modest success. Contraceptive prevalence has stagnated at 30%—the lowest level among neighboring countries.[1] Use of modern contraceptive methods to delay or limit pregnancy is 22%. The most widely used modern method is female sterilization (8%) while use of long-acting reversible contraceptives is at about 2% (mostly from use of IUDs). About one-third of births occur within birth intervals of less than 24 months.[1] One-quarter of women of reproductive age want to space or limit their births but are not using contraception and therefore have an unmet need.[1] This is mainly due to issues related to access to services, restrictions on women's mobility outside their homes,[2] fear of side effects of modern contraceptives, and perceived social disapproval from their spouses or other family members,[3] partly attributed to misconceptions about the permissibility of family planning in Islam.

The majority (97%) of Pakistan's population is Muslim.[1] The influence of religion is pervasive in all aspects of an individual's life, including personal matters such as managing family size. A study conducted by the Pakistan National Institute of Population Studies showed that women in communities where *Ulema* (Muslim religious leaders) gave permission to use birth spacing methods were 1.7 times more

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likely to use contraceptives than women in communities where *Ulema* did not allow family planning programs (Odds Ratio [OR]=1.704, 95% confidence interval [CI]=1.11–2.6; P=0.014).[4] A qualitative study in rural Pakistan found that men often cited religion as an important reason for not using contraception,[5] and the Pakistan Demographic and Health Survey reported that 5% of married women do not use contraception due to religious reasons.[1]

Although there has never been any vocal opposition to family planning by religious conservatives in Pakistan, successive governments fearful of a backlash have been cautious in involving religious leaders in family planning activities. This lack of engagement has led to ambiguity in the minds of the public about the acceptability of family planning in Islam.

The rationale for family planning propagated over the years focused primarily on reducing family size to alleviate demographic and economic issues facing the country, which many saw as an infringement by the state to their personal decision-making freedom. Thus, individuals failed to appreciate the direct benefits of family planning on their lives. Information on the health benefits of family planning, which could have influenced the stance of religious leaders, was unfortunately not available to them. It was not until 2006 that a conference of religious leaders was organized to develop religious consensus on the issue.

Between 2007 and 2012, the Population Council in Pakistan, leading a consortium of 7 organizations, implemented a family planning project called ''FALAH'' (Family Advancement for Life and Health), with funding from the U.S. Agency for International Development (USAID). The project aimed to reduce unmet need for family planning by improving access to services in 20 districts of the country.

We repositioned family planning as a health intervention, introducing the concept of ''birth spacing saves lives'' based on the principles of healthy timing and spacing of pregnancies (HTSP) to reduce maternal, newborn, and child mortality and morbidity. To accomplish this, we involved the Department of Health more fully. One obvious advantage of doing so was that the Department of Health has a much larger infrastructure with 14,287 facilities compared with the 2,891 family welfare centers of the Population Welfare Department. We worked to improve the quality of care offered by public-sector facilities of both departments by ensuring that they were well-stocked with an uninterrupted supply of contraceptives and by training providers to offer client-centered family planning services.

Religious opposition sometimes can be a deterrent to contraceptive use.

A key component of the FALAH project was a behavior change training program for providers and medical college faculty that included modules on (see supplementary material):

- Instilling a sense of self-worth among the providers and encouraging them to view their work as a social responsibility
- How to communicate with clients on issues related to gender norms and power dynamics at the household level
- Use of the SAHR framework (Salutation, Assessment, Help, Reassurance) for holistically assessing and meeting clients' needs through mutual negotiations
- Enhancing providers' knowledge and skills on contraceptive methods, developed in collaboration with Jhpiego, a technical partner on the FALAH project

We also developed a module on ''The Islamic Viewpoint on Family Planning'' (see supplementary material). In this paper, we describe the rationale and process for developing this particular module. We also include feedback from interviews with faculty and providers about the impact of the training module on their teaching and practice, respectively, as well as results of the FALAH project overall on contraceptive use.

INTERVENTION DESCRIPTION

Needs Assessment

We first undertook an extensive needs assessment of medical institutions and colleges to identify areas that needed strengthening in teaching family planning. Our discussions with university vice chancellors and faculty members revealed that, due to a variety of reasons, they did not discuss family planning with their students thoroughly. Among the many weak areas identified, the one highlighted most often was faculty's concern about whether family planning was allowed in Islam.

For this reason, we developed 2 sets of training programs to deliver client-centered family planning services: one to train existing health care providers and the other to train faculty of medical colleges. Both training pro-

grams included the module on Islam and family planning.

Obtaining Religious Consensus

In 2009, in collaboration with the Ministry of Population Welfare, we sponsored a national seminar entitled ''Involvement of Religious Leaders in the Population Welfare Program.'' We brought together noted Muslim scholars from the 2 major sects in Islam (Sunni and Shia) and the major subsects. The majority of Muslims in the country follow the Sunni Hanafi School of jurisprudence. The Sunnis are further divided into two subsects, the Barelvis and Deobandis.

Muslim scholars in Pakistan developed consensus on the permissibility of family planning in Islam.

During the seminar, we deliberated in groups with the scholars about the close scientific link between birth spacing, family size, and maternal and infant health outcomes, especially the relation between birth intervals and infant mortality based on figures available in the 2006–07 Pakistan Demographic and Health Survey and on international evidence.[6–9] The seminar culminated in a consensus report in which the scholars unequivocally agreed that using modern and traditional contraceptive methods to space births was in no way contrary to Islamic teachings, allowing individuals to freely decide upon the number and timing of their children.[10] We later also captured the scholars' views in a short video documentary (in Urdu with English subtitles) entitled *Farishton Ne Bhi Poocha* (Even the Angels Dared to Ask) (see http://www.youtube.com/watch?v=GBRtZTlZdHU).

Review of Existing Curricula

After the seminar, we reviewed existing curricula and materials on the subject developed in other countries to explore the arguments and explanations that established the permissibility of family planning in Islam.[11–14] We also studied edicts passed on the subject by the Grand Muftis (chief jurists who interpret Muslim law) of Jordan and Egypt.

After this review, we made a conscious decision to focus primarily on the Quran (the sacred text of Islam) because we believed that people's misconceptions had resulted from an inability to correctly collate and interpret the various verses of the Quran that deal with family responsibility and wellbeing. For instance, some Muslim religious leaders have interpreted that, although family planning is not explicitly prohibited in the Quran, it is not implicitly allowed—that is, that the Quran is silent on the issue.[15] However, an in-depth study of Quranic injunctions reveals that this is not the case.

We also thought that focusing on Quranic teachings would be the most direct approach and difficult for people to contradict, therefore preventing any counterarguments and controversy.

Introducing the Module

The FALAH project trained 10,534 facility-based health care providers, faculty members of the affiliated colleges of 6 medical universities, and managers and trainers of training institutes of the Population Welfare Department in the 20 project districts.

For the providers' training program, we developed master trainers from the Departments of Health and Population Welfare. These master trainers conducted the step-down trainings in batches consisting of 20 participants each. We oversaw the first iteration of the step-down trainings. For quality assurance, we made periodic visits to the training sites and provided any necessary feedback to the trainers using a training checklist.

For the faculty training program, the training team directly trained faculty members from the departments of Anatomy, Physiology, Community Medicine, Pharmacology, Pediatrics, and Gynecology and Obstetrics.

The module on Islam and family planning was interactive and encouraged discussion. Participants were asked at the beginning of the training session to list their own and their clients' perceptions about the permissibility of family planning in Islam. Misconceptions ranged from labeling family planning as a conspiracy to limit the size of the Muslim population to equating contraception with infanticide. Trainers used this list to provide counterarguments during the training, to help trainees address their own misconceptions, and to use the same arguments to convince others.

We also asked each participant to complete the following sentence: ''For developing an ideal Islamic society, Muslim citizens should be _____.'' Participants contributed such words as ''strong,'' ''educated,'' ''healthy,'' and ''pious.''

We then asked participants what prerequisites they believed they had to fulfill to achieve these objectives. Responses consistently included: investing more in their children by giving them quality education, a proper upbringing, appropriate healthcare, and adequate time and attention. Participants argued that these requirements could be adequately fulfilled only if families

spaced their births and had a manageable family size.

Next, we introduced the Quranic view on family wellbeing. Trainers explained that because the message of the Quran is for all times and that it provides its followers with a complete code of life, Muslims can seek guidance about contemporary issues by examining relevant principles laid down in the Quran.

Accordingly, trainers introduced participants to 6 specific verses of the Quran related to creating a healthy and pious family that have been cited in a number of materials on Islam and family planning.[11–12]

The starting point of the discussion was the Quranic verse that relates to spousal responsibility before entering matrimony:

> *Let those who find not the wherewithal for marriage keep themselves chaste, until Allah gives them means out of His grace.*[16(24:33)]

This verse enjoins believers to enter into marriage *only* if one is capable of bearing the responsibility of raising a family and is in a position to meet the physical, social, and economic needs of the spouse and offspring. The explanation of this verse is that it is incumbent upon the husband to provide for the wellbeing and needs of his spouse and future offspring. If he is unable to do so, Allah advises him not to marry and to remain chaste until such time that Allah gives him the means to do so. The verse clearly outlines the concept of responsible parenthood, as marriage is not simply the union of individuals but also an institution for raising a family.

Next, participants discussed the meaning and interpretation of the following Quranic verse, which succinctly describes the attributes of a family:

> *And those who pray, ''Our Lord! Grant unto us wives and offspring who will be the comfort of our eyes, and give us (the grace) to lead the righteous.*[16(25:74)]

The Holy Quran enjoins Muslims to ask Allah for spouses and children that bring peace and tranquility to the heart. Children who bring ''comfort to the eyes'' of the parents are those who are undoubtedly healthy, educated, well-behaved, and devout Muslims. This requires a heavy investment of time and resources in the upbringing of children and meeting the requirements and needs of the spouse by providing them with the requisite amount of attention and care.

In this next verse, the Quran has equated possessions and progeny and labeled them as a source of trial in this world:

> *And know ye that your possessions and your progeny are but a trial and that it is Allah with whom lies your highest reward.*[16(8:28)]

The Quran equates offspring and material possessions, describing both as a source of trial and tribulation. The lack of possessions and offspring can become a source of great anguish for parents. Similarly, excess wealth and offspring can be a source of trial as parents can become preoccupied with concerns and worries of how to protect and look after them and hence become distracted from following religious injunctions. A state of moderation and balance is therefore the ideal that one must pursue.

In the next 2 verses, the Quran lays down the principle of prolonged breastfeeding that physiologically leads to spacing between pregnancies—pointing to the permissibility and even encouragement of birth spacing.

> *The mothers shall give suck to their offspring (breastfeed) for two whole years.*[16(2:233)]

> *In pain did his mother bear him, and in pain did she give him birth. The carrying of the (child) to his weaning is (a period of) thirty months.*[16(46:15)]

In these verses, the Quran is categorical about establishing the right of the child to be breastfed for at least 2 years. Medical science has established that breastfeeding has numerous health benefits in terms of enhancing children's immunity and protecting them from infections, apart from being a sterile source of nutrition. Furthermore, prolonged (exclusive) breastfeeding leads to lactational amenorrhea that prevents pregnancy, resulting in spacing between births. This, in turn, allows the mother to recover her strength after delivery and ensures that the offspring continues to receive adequate nutrition and maternal attention.

In the contraceptive technology training session, we discussed the Lactational Amenorrhea Method in detail and explained that the effectiveness of breastfeeding in suppressing ovulation (and preventing pregnancy) is reduced once weaning starts, at which point exogenous contraceptives are needed to prevent pregnancy.

We also showed the trainees a diagram that explained how exogenously administered hormonal contraceptives and breastfeeding follow the same mechanism acting on the hypothalamic pituitary pathway in the brain leading to a suppression of ovulation and prevention of pregnancy. We stressed that this is the principle that forms the basis of the permissibility of contraception in Islam.

The final verse discussed with the trainees relates to maternal health and wellbeing:

> *Your women are lands (tilth) for you; so approach your tilth when or how you will.*[16(2:223)]

Verses from the Quran encourage infant breastfeeding for at least 2 years—establishing the principle of prolonged breastfeeding that leads to birth spacing.

In this verse, the Quran has compared women's reproductive capability to the cultivable fields that produce food. All wise farmers know that they have to meet certain preconditions to obtain a good yield, such as providing nutrients to the soil, not sowing out of season, and giving gaps between cultivating the crops so that the soil can regain its productive capacity. Similarly, for families to reap healthy offspring, mothers' physiological needs have to be met in terms of providing proper diet and nutrients during and after pregnancy and allowing them to recoup their energy and strength lost during childbirth before becoming pregnant again. Through this metaphor, we can infer that the Quran once again reinforces the concept of birth spacing and also establishes women's rights to be respected and cared for.

Trainers also informed participants that Prophet Mohammad (peace be upon him, pbuh) never forbade Muslims to practice *al-'azl* (coitus interruptus, or the traditional family planning method of withdrawal), which was available to Muslims at that time.[17–18]As a result, the 5 major Islamic schools of thought (Hanafi, Maliki, Ja'fari [Imami], Hanbali, and Shafi) have permitted the practice of coitus interruptus.[14,19]

At this point, trainers synthesized the conversation and discussed some of the common arguments presented against family planning. For example, to counter the common argument that family planning is an attempt to check the growth of the Muslim population, trainers explained that the size of the Muslim community grew phenomenally after the advent of Islam not because of procreation but primarily because of the rapid conversions that took place, as a result of people being impressed by the message and pious conduct of the Prophet Mohammad (pbuh). Trainers also explained that family planning is not akin to infanticide, a practice explicitly prohibited in Islam, because it prevents the process that leads to the development of an infant.

Trainers also showed the video documentary of the endorsement of family planning by major religious scholars of Pakistan to further augment the arguments that had been discussed earlier. Trainers stressed that birth spacing helps save the lives of mothers and newborns. The trainers also provided participants with a list of edicts on Islam and family planning issued by Muslim scholars.

EVALUATION METHODS

We conducted a situation analysis in 14 districts of 3 provinces of Pakistan (Khyber Pakhtunkhwa, Punjab, and Sindh) to assess the effect of the FALAH project, which included interviews with providers (both those who did and did not receive training). We randomly sampled 11 health facilities in each of the 14 districts and interviewed a total of 175 providers to assess their family planning knowledge. To assess the specific module on Islam and family planning, we held focus group discussions with providers before and after the training session to evaluate changes in perspectives and opinions regarding permissibility of family planning in Islam.

We also interviewed faculty members 2 years after the training to obtain their feedback on the overall training program, including on the Islam and family planning training module.

Finally, to measure impact of the FALAH project overall, which included several components to improve access to family planning, we conducted representative baseline and endline surveys of married women of reproductive age (ages 15 to 49) in 14 districts to measure changes in contraceptive prevalence and unmet family planning need. Security reasons prevented us from conducting the surveys in the remaining 6 project districts in the fourth province (Balochistan). In the 2008/09 baseline survey, we collected data from 10,604 women, and in the 2011/12 endline survey, from 12,403 women, through systematic random sampling of households. Each eligible married woman of reproductive age available in selected households was interviewed.

We submitted the evaluation proposal to the Institutional Review Board of the Population Council, which determined that the work met all requirements for informed consent and protection of confidentiality and that it was exempt

from federal regulations because it represented minimal risk to the human subjects.

RESULTS

The ''Basic Minimum Family Planning Contents'' training package with the module on Islam and family planning has been introduced to 174 faculty members of 6 major universities of Pakistan and their affiliated medical colleges: the University of Health Sciences Lahore; Dow University of Health Sciences Karachi; Khyber Medical University Peshawar; Shaheed Mohtarma Benazir Bhutto Medical University, Larkana; Peoples University of Medical and Health Sciences for Women Shaheed Benazirabad; and Liaquat University of Medical and Health Sciences, Jamshoro. The training module also has been incorporated into the teaching program conducted by the Population Welfare Program through its Regional Training Institutes all over Pakistan. This will undoubtedly ensure that existing as well as future providers continue to benefit from its contents.

Perceptions of Medical College Faculty

Feedback from participants through follow-up interviews indicates that the module has helped medical college faculty address their own misconceptions and concerns that prevented them in the past from discussing the topic openly and candidly. Faculty members have also indicated that the module helped them provide appropriate responses to questions and arguments raised by students. Overall, the module has enhanced their level of confidence and made it easier to introduce the topic of family planning in a more convincing and non-controversial manner.

> *The module on Islam and family wellbeing has been most helpful as it allows us to answer queries of our students from a religious perspective. We explain that the concept of healthy timing and spacing of pregnancies is in consonance with Islamic teachings. We start our discussion by explaining the Lactational Amenorrhea Method and elaborate this by quoting Quranic verses. This greatly helps in establishing the permissibility of birth spacing and adoption of contraception in Islam.*
>
> —Head of Department of Community Medicine, Quaid-e-Azam Medical College Bahawalpur

Faculty members also appreciated the video with the endorsement of religious scholars, which provides an additional level of support to their arguments and clarifies students' misconceptions.

Knowledge and Perceptions of Health Care Providers

More of the trained providers had an accurate understanding of the birth spacing concept per the WHO-recommended definition of HTSP (38%) than untrained providers (5%). In addition, more of the trained providers (78%) accurately explained family planning as a means to ''plan your family according to your resources'' compared with untrained providers (50%). Both concepts were covered in the module on Islam and family planning.

In addition, group discussions with trained providers indicated that the module on Islam and family planning had changed their perceptions about the permissibility of family planning.

> *Before attending the training, I viewed family planning as a sin … My views are now completely changed. I will now become an advocate for family planning.*
>
> —Senior Medical Officer, Jaffarabad, Balochistan

Effects on Contraceptive Use

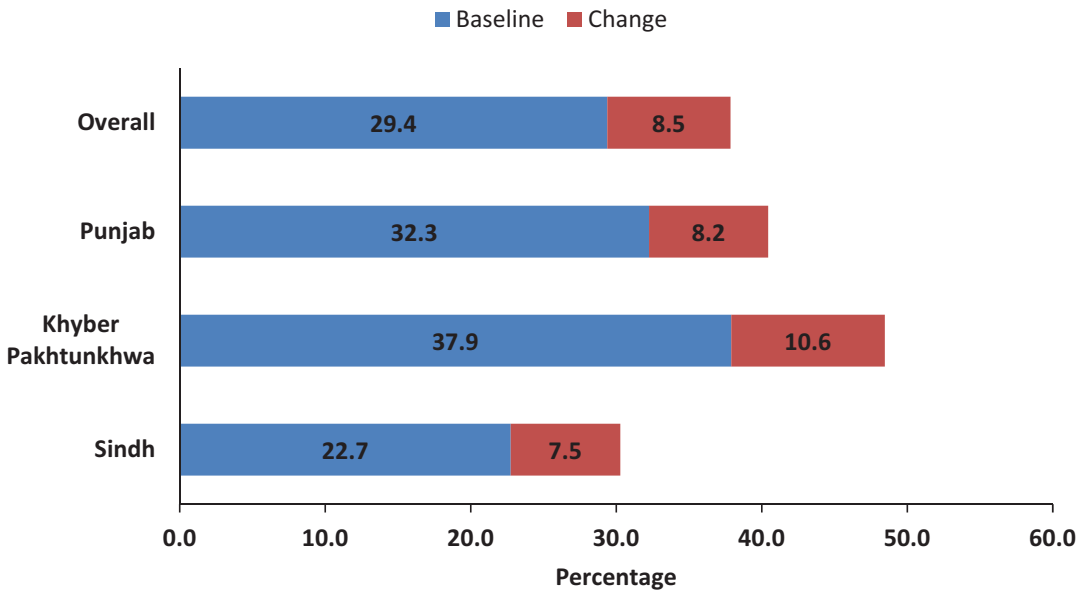
Although it is difficult to tease out the impact of the training component of the FALAH project through the situation analysis, overall we found that facilities with trained providers received, on average, 60% more family planning clients over a 6-month period prior to the assessment compared with facilities with untrained providers.[20]

In the 3.5 year-period of active program implementation, we found an overall increase of 9 percentage points in contraceptive prevalence in the program implementation districts—from about 29% to 38% (see Figure).[20–21] We emphasize that this can in no way be attributed solely to the training as there were many additional inputs that facilitated clients' access to family planning services, yet the importance of the Islam and family planning module cannot be underestimated.

DISCUSSION

Until recently, the public-sector family planning program in Pakistan did not make any serious attempt to seek the support of religious scholars in openly approving family planning. Other Muslim countries, such as Bangladesh, Egypt, Indonesia,

FIGURE. Change in Contraceptive Prevalence in FALAH Project Implementation Provinces



Baseline survey among married women of reproductive age (ages 15–49) was conducted in 2008/09; endline survey in 2011/12. Surveys were not conducted in Balochistan province due to security reasons.

Iran, and Tunisia, obtained endorsement from religious scholars much earlier, contributing to the success of their family planning programs. For instance:

- Morocco organized the Rabat Conference on Family Planning in 1971.
- Iran issued a national family planning policy in 1989 that the highest religious authorities had endorsed. Iranian religious leaders collaborated with health practitioners to promote family planning, using not only electronic and print media but also the pulpit of the mosques. In a span of 20 years, contraceptive prevalence in Iran rose from 37% to 73%.[15,22–23]
- Bangladesh made concerted efforts early on in its family planning program to educate Muslim clergy about the health rationale of family planning.[22] Indonesia arranged a congress on Islam and Population Policy in 1990. Religious leaders have been invited to participate in seminars and workshops with the goal of increasing their family planning knowledge, influencing their attitudes about contraception, and motivating them to advocate family planning.[24]
- In a survey in Jordan, religious leaders who said that they believed family planning was acceptable in Islam registered significantly higher agreement scores ($P<.001$) on statements about the benefits of family planning than those who said that family planning was not allowed or who were uncertain.[25] This suggested that religious leaders should not be ignored as potential proponents of family planning.
- Egypt obtained edicts supporting family planning from scholars at Al-Azhar University, the most reputed seat of Muslim learning, and Egypt's Grand Mufti publicly proclaimed that family planning was allowed in Islam.[26]

Our decision to include a module on the Islamic perspective on family planning in the training curricula for providers and medical faculty was indeed timely in not only removing misconceptions but also promoting family planning in Pakistan. Other countries that have

sizeable Muslim populations with low rates of contraceptive prevalence could benefit from this module, particularly those countries that grapple with inhibitions to adopting family planning on religious grounds, such as Afghanistan, Chad, Mali, Mozambique, and Niger.

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ORIGINAL ARTICLE

Forest cover associated with improved child health and nutrition: evidence from the Malawi Demographic and Health Survey and satellite data

Kiersten B Johnson,[a] Anila Jacob,[b] Molly E Brown[c]

In Malawi, net forest cover loss over time is associated with reduced dietary diversity and consumption of vitamin A-rich foods among children. Greater forest cover is associated with reduced risk of diarrheal disease. These preliminary findings suggest that protection of natural ecosystems could play an important role in improving health outcomes.

ABSTRACT

Healthy forests provide human communities with a host of important ecosystem services, including the provision of food, clean water, fuel, and natural medicines. Yet globally, about 13 million hectares of forests are lost every year, with the biggest losses in Africa and South America. As biodiversity loss and ecosystem degradation due to deforestation continue at unprecedented rates, with concomitant loss of ecosystem services, impacts on human health remain poorly understood. Here, we use data from the 2010 Malawi Demographic and Health Survey, linked with satellite remote sensing data on forest cover, to explore and better understand this relationship. Our analysis finds that forest cover is associated with improved health and nutrition outcomes among children in Malawi. Children living in areas with net forest cover loss between 2000 and 2010 were 19% less likely to have a diverse diet and 29% less likely to consume vitamin A-rich foods than children living in areas with no net change in forest cover. Conversely, children living in communities with higher percentages of forest cover were more likely to consume vitamin A-rich foods and less likely to experience diarrhea. Net gain in forest cover over the 10-year period was associated with a 34% decrease in the odds of children experiencing diarrhea (P=.002). Given that our analysis relied on observational data and that there were potential unknown factors for which we could not account, these preliminary findings demonstrate only associations, not causal relationships, between forest cover and child health and nutrition outcomes. However, the findings raise concerns about the potential short- and long-term impacts of ongoing deforestation and ecosystem degradation on community health in Malawi, and they suggest that preventing forest loss and maintaining the ecosystem services of forests are important factors in improving human health and nutrition outcomes.

INTRODUCTION

Forests provide critical resources and processes that benefit human populations, known as ecosystem services, including food, clean water, fuel, natural medicines, and pollination. More than 1.5 billion people worldwide rely on forest products for their livelihoods.[1] Yet globally, about 13 million hectares of forests are lost every year, primarily due to agricultural expansion, extraction of natural resources, and human settlement.[2] Deforestation is a major driver of biodiversity loss, which continues unabated despite global efforts to stem this loss.[3] According to the Board of the Millennium Ecosystem Assessment, loss of ecosystem services poses a considerable barrier to achieving the Millennium Development Goals to reduce poverty, hunger, and disease.[4] (The United Nations Secretary-General called for the Millennium Ecosystem Assessment in 2000 to assess the consequences of ecosystem change on human well-being.)

Although all populations fundamentally depend on the natural environment, people living in rural areas of the developing world are most directly dependent on

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More than 1.5 billion people worldwide rely on forest products for their livelihoods, but 13 million hectares of forests are lost every year.

ecosystem services to meet their basic needs.[5] As biodiversity loss and ecosystem degradation continue at unprecedented rates, there is increasing concern about potential public health impacts, especially among the world's most vulnerable populations.

Research on the links between human health and deforestation is limited, but a handful of studies suggest that ecosystem degradation has negative impacts on public health. For example, a Nepal study from the 1980s showed that deforestation increased women's time spent gathering essential forest products (such as fuel wood and fodder for livestock) that was significant enough to reduce the amount of time they spent on agricultural production, food preparation, and breastfeeding.[6] Researchers in Madagascar showed, through modeling, that anemia incidence in children would increase by 29% if they no longer had access to wildlife as a food source, either due to species extinction or strict enforcement of conservation policies.[7] Among the poorest children, anemia cases would triple. In a study of 54 health districts in the Brazilian Amazon, researchers found that a 4% increase in deforestation rates was associated with a 48% increase in malaria incidence.[8]

To better understand the potential health and nutrition impacts of deforestation, we conducted a case study of Malawi using 2010 Demographic and Health Survey (DHS) data linked, via geographic information system (GIS) points, with satellite remote sensing data on forest cover and change in forest cover over a decade's time.

HYPOTHESIS

Ecosystems provide several benefits to people, such as food, water, flood protection, waste absorption, and crop pollination.

We hypothesized that deforestation and lower percentages of forest cover (proxies for degraded environments) result in declining ecosystem services, which then open pathways to child undernutrition and poor health.

Ecosystem services are defined as the short- and long-term benefits people obtain from ecosystems, comprising:

- **Provisioning** goods and services (the production of basic goods such as food, water, fish, fuels, timber, and fiber)
- **Regulating** services (such as flood protection, purification of air and water, waste absorption, disease control, and climate regulation)
- **Cultural** services (spiritual, aesthetic, and recreational benefits)
- **Supporting** services necessary for the production of all other ecosystem services (including soil formation, production of oxygen, crop pollination, carbon sequestration, photosynthesis, and nutrient cycling)

Poor, rural residents often rely on forest foods for their nutrients.

Conversely, we hypothesized that more biodiverse environments, represented by higher percentages of forest cover, have comparatively better capacity to provide essential ecosystem services, which then translate into improved human nutrition and health outcomes.

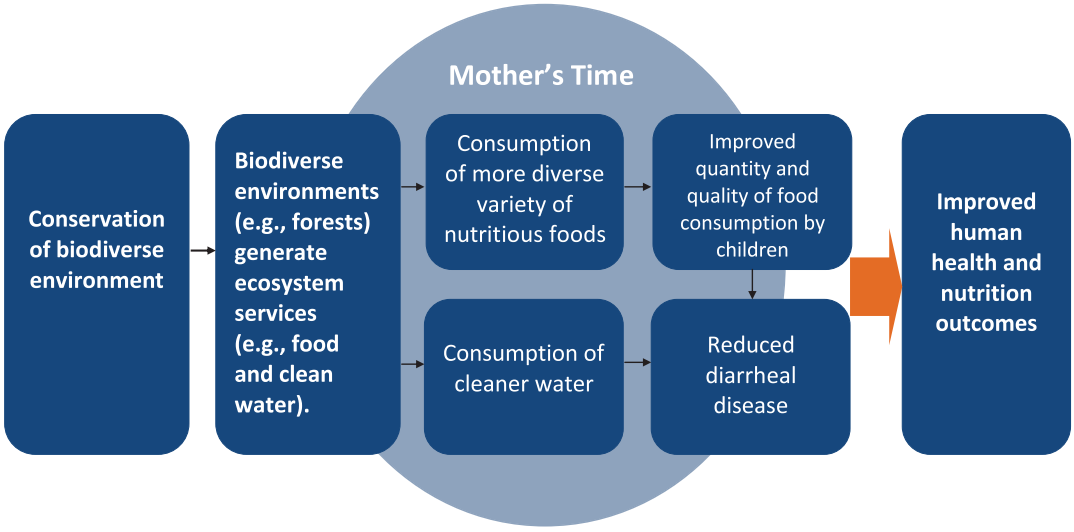
Our outcomes of interest include children's dietary diversity, consumption of vitamin A-rich foods, stunting, and experience of diarrheal disease. We expect these outcomes to be associated particularly with the level and quality of *provisioning* and *regulating* ecosystem services.

A comprehensive description of the complex and nonlinear relationships between the environment and human health outcomes is beyond the scope of this paper. However, our conceptual framework provides a simple illustration of the 3 hypothesized relationships that we explore in this analysis: (a) between forest cover and nutritional outcomes; (b) between forest cover and health outcomes; and (c) the mediating function of women's time on the relationship between forest cover and nutritional outcomes (Figure 1).

Hypothesized Pathways Between Forest Cover and Nutritional Outcomes

Provisioning services provided by forests are an important source of food for the rural poor, who often rely on bushmeat and other non-timber forest products (NTFPs) for their protein and micronutrients. In the Congo Basin, bushmeat provides about half of people's protein intake.[9] In a recent study of rural households in western Ghana, researchers found that residents routinely consumed a variety of forest foods, including bushmeat, plants, fruits, and snails.[10] Residents of poorer households consumed these items more often than residents of wealthier households—on average, 5 days a week compared with 3 days a week, respectively. Furthermore, many households also sold various NTFPs at local markets, generating additional income that improved food security. In rural Malawi, researchers found that food from forests provided a safety net during times of crop failure; study participants reported that, on average,

FIGURE 1. Conceptual Framework of Pathways Between Biodiverse Environments and Human Health and Nutrition Outcomes



We hypothesize that biodiverse environments are better able to produce ecosystem services, such as food and clean water, which, in turn, improve the quantity and quality of food consumption by children and reduce diseases, leading ultimately to better health and nutrition outcomes. Mother's time acts as a mediating factor between biodiversity and child health and nutrition outcomes.

more than 50% of their meals were derived from forests during times of famine.[11]

These studies demonstrate reliance on NTFPs, particularly among the rural poor, and provide a strong basis for the hypothesis that deforestation results in decreased availability of forest foods, which in turn can lead to comparatively poorer nutritional outcomes among children as well as adults.

Hypothesized Pathways Between Forest Cover and Health Outcomes

Populations living near intact forest ecosystems are closer to forest plants and insect life that naturally decompose human and animal waste and convert it to energy (a *regulating* ecosystem service). Forest degradation reduces these functions, which in turn degrade the ability of insect life to process animal waste.[12]

In Indonesia, a study found that residents of households living downstream from protected forested watersheds were less likely to experience diarrhea than those living downstream from unforested watersheds, demonstrating the regulating services of forests in improving quality of drinking water.[13] Similarly, we hypothesize that children living in households close to forest cover will experience reduced odds of diarrheal disease compared with children not living close to forest cover.

Forests help to improve the quality of drinking water.

Hypothesized Mediating Function of Women's Time on the Relationship Between Forest Cover and Nutritional Outcomes

The Nepal study[6] demonstrated a negative association between deforestation and women's time allocation on nutrition-related functions such as food preparation and breastfeeding, subsequently limiting women's ability to provide nutrition to their children. Although we cannot test the role of women's time allocation in mediating the hypothesized relationship between forest cover and child health and nutrition outcomes in this study, we believe it is important to represent this mediating function in the

conceptual model, given the well-demonstrated centrality of women's role in ensuring child health and nutrition outcomes.

DATA AND METHODS

Study Site Selection

We selected Malawi as our study country given its very high rates of deforestation, child undernutrition, and child mortality, as well as the direct dependence of the majority of the population on ecosystem services. Malawi has lost almost 600,000 hectares of primary forest between 1990 and 2005, with regional deforestation rates as high as 3.4% per year.[14] Over 80% of Malawi's population is rural and highly dependent on natural resources for food, fuel, and maintenance of livelihoods.[14–15] Forty-seven percent of children are stunted, and the under-5 mortality rate is 112 deaths per 1,000 live births.[16]

Data

Demographic and Health Surveys Data

We obtained nutritional status and dietary consumption data, as well as other individual-level characteristics, from the 2010 Malawi DHS.

The DHS are a key source of comparative quantitative data across developing countries on demographic and health indicators, including for reproductive health, maternal and child health, and nutritional status of women and children. They are nationally and sub-nationally representative household surveys with large sample sizes and detailed data obtained by interviewing women of reproductive age (15–49 years old) to obtain information about their children and other household members. The data also include information on household and other socioeconomic characteristics of sampled women and their households.

The DHS are implemented using a stratified 2-stage cluster sampling design. In Malawi, more than 23,000 households participated in the 2010 survey (household response rate: 98%; individual women's response rate: 97%).[16] For more information about the DHS, see www.measuredhs.com.

Satellite Remote Sensing Data

We used 2 types of satellite remote sensing variables in this analysis: the Vegetation Continuous Fields (VCF) product[17] and the Normalized Difference Vegetation Index (NDVI).[18] A full technical description of the satellite remote sensing data sets used in this analysis is available in the supplementary Appendix; the variables are described below.

GPS Data and Displacement

During DHS fieldwork activities, surveyors collected the GPS coordinates for the center of the populated area surveyed (cluster centroid) using handheld GPS units. Of importance to this analysis is that the GPS coordinates are displaced to ensure respondent confidentiality.[16] The displacement is randomly applied so that rural points contain a minimum of 0 km and a maximum of 5 km of positional error. Urban points contain a minimum of 0 km and a maximum of 2 km of error. A further 1% of the rural sample points are offset a minimum of 0 km and a maximum of 10 km.

We overlaid DHS data with average NDVI data derived from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) (a key satellite instrument that views the Earth's surface) at each DHS cluster centroid for 2010. We used a similar procedure with the VCF product to link the percent forest cover variable and the change in forest cover variable to the 2010 Malawi DHS data set.

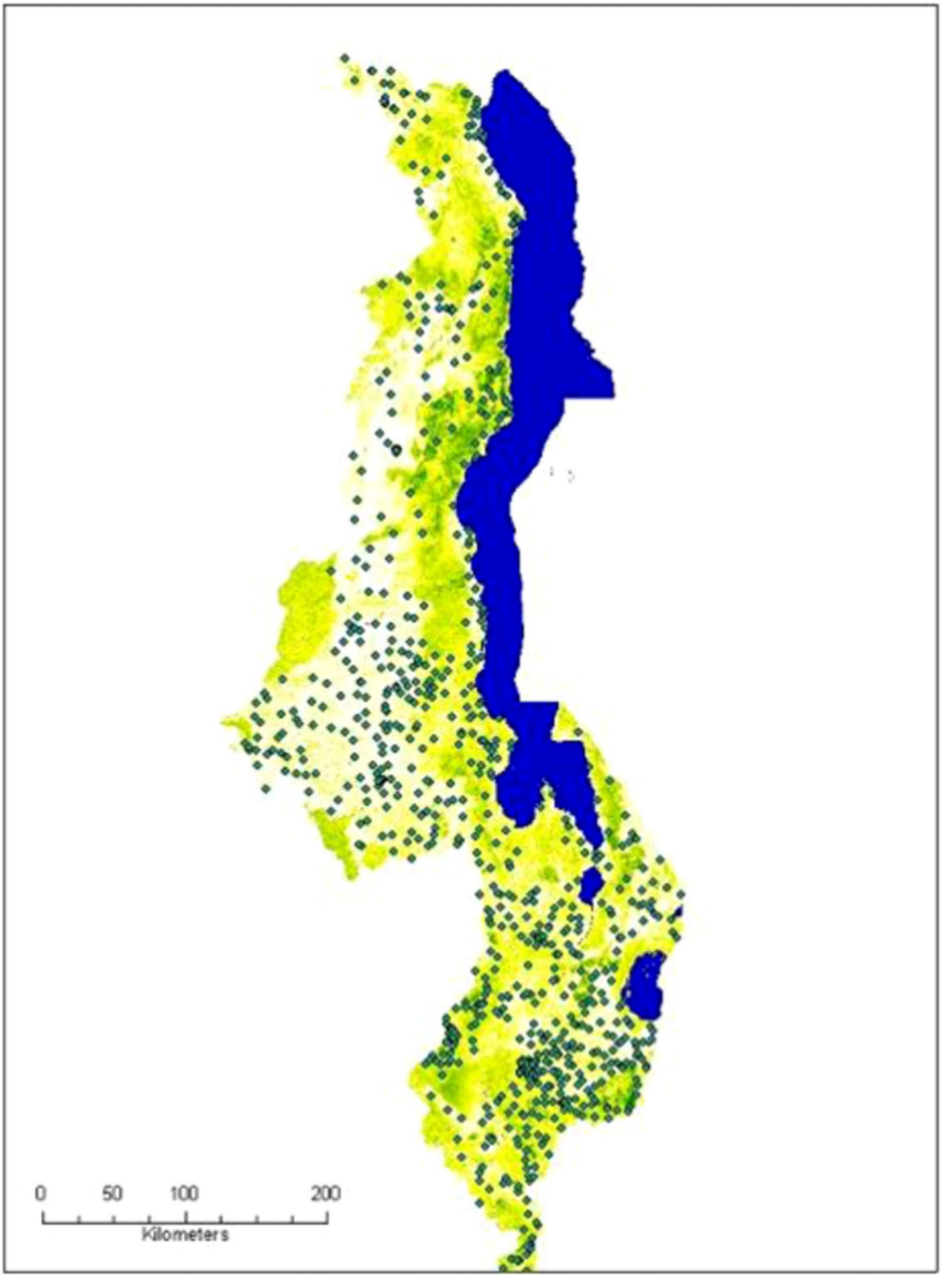
We chose to aggregate the satellite data to 5 km resolution to ensure that even after displacement of DHS GPS coordinates, environmental variability and tree cover were accurately represented for each DHS cluster. Displacement errors were below the spatial resolution of the satellite remote sensing.

Variable Definitions

Dependent Variables

Our analysis explored 4 dependent, dichotomous variables: severe stunting, dietary diversity, consumption of vitamin A-rich foods, and diarrhea.

1. **Severe stunting:** The height, weight, and age of all children under age 5 were collected during DHS fieldwork using UNICEF SECA weight scales and Shorr height boards; these data were then used to calculate measures of child stunting. Stunting, or height-for-age, reflects the long-term nutritional status of a child, indicating impacts of both nutritional deficiencies and bouts with illnesses. Children with height-for-age z-scores that are less than -3 standard deviations from the median of the reference population are considered to be severely stunted. We coded



Map of Malawi showing 2010 forest cover overlaid with sampling clusters from the 2010 Malawi DHS.

severely stunted children with a "1" and all remaining children with a "0."

2. **Dietary diversity:** The DHS instrument collects 24-hour recall data on dietary consumption for the most recently born child under the age of 3. Our definition of dietary diversity was based on the Minimum Dietary Diversity indicator[19] defined by an expert

working group led by the World Health Organization–that is, the proportion of children 6–23 months of age who receive foods from 4 or more of the following food groups: (a) grains, roots, and tubers; (b) legumes and nuts; (c) dairy products (milk, yogurt, and cheese); (d) flesh foods (meat, fish, poultry, and liver/organ meats); (e) eggs; (f) vitamin-A rich fruits and vegetables; and (g) other fruits and vegetables. For our definition, we also included breast milk as one of the food groups, given its importance as a source of nutrition for children and that breastfeeding practices are likely to be impacted by deforestation. We also included all children under age 3 in our analysis, given that many children are given foods other than breast milk prior to 6 months of age, despite the recommendation that infants be exclusively breastfed until that age. We coded children who consumed foods from 4 or more food groups with a ''1'' and all remaining children with a ''0.''

3. **Consumption of vitamin-A rich foods:** Data on consumption of vitamin-A rich foods were also drawn from the 24-hour recall data on dietary consumption for the most recently born child under the age of 3, described above. All children under age 3 were included in the analysis, and we coded children who consumed vitamin-A rich foods (fruits or vegetables) with a ''1'' and all remaining children with a ''0.''
4. **Diarrhea:** In DHS surveys, mothers of children under age 5 are asked whether their children have experienced a bout of diarrhea in the past 2 weeks. We coded children whose mothers reported in the affirmative with a ''1'' and all remaining children with a ''0.''

Independent Variables of Interest

We calculated our key independent variables from the remotely sensed VCF data product mentioned earlier. The VCF contains proportional estimates for vegetative cover types; it shows how much of a land cover, such as ''forest'' or ''grassland,'' exists on the land surface.

The VCF product was averaged to 5 km and was used to generate 2 independent variables:

1. Percentage of forest cover associated with each DHS sampling cluster (0–9%, 10–19%, 20–29%, 30–39%, 40–49%, and 50–59% forest cover)
2. Another categorical variable reflecting changes in forest cover over a decade (no change, net forest loss, and net forest gain) for the sampled DHS cluster

The variable reflecting decadal change in forest cover leverages the longitudinal nature of the satellite remote sensing data. Adding this temporal dimension to the analysis strengthened our study considerably over using only a static measure of forest cover taken at the time of the survey, allowing us to test, in effect, the relationship between forest change over time (loss or gain) and our outcomes of interest.

Control Variables

Variables controlled for in the analysis include child's age (grouped into 6-month categories), mother's education (none, primary, secondary or higher), urban or rural residence, household wealth quintiles, number of years resident in the current location, and a remotely sensed vegetation index (NDVI). The model for diarrhea includes whether the household has access to a safer toilet facility and water source. Selection of variables was driven in part by data availability, given that we are analyzing secondary source data.

The variable on *mother's education* is a self-reported measure reflecting the mother's highest education level achieved at the time of the survey. Respondents are asked to report the level of highest achievement and the grade achieved within that level. Our analysis used a recoded categorical variable that reflects attainment of: no education, primary education, and secondary education or higher. Mother's education is related to a child's height-for-age[20]: mothers who are better-educated may be more knowledgeable about nutrition and optimal child care behaviors, enabling them to improve health outcomes for their children.

Relative *household wealth* is measured using an asset-based index: data on household asset ownership collected during the DHS household interview are dichotomized (yes/no to indicate ownership of each asset) and entered into a statistical procedure known as principal components analysis (PCA) that assigns a weight to each asset. The asset values for each household are then summed taking into consideration the weights, and a total household score is given. The

household population is then divided into quintiles on the basis of the score given to their household.[21]

The *NDVI* is a satellite remote sensing variable that quantifies the concentrations of green leaf vegetation on the ground, providing an integrated estimate of vegetation health and a means of monitoring changes in vegetation over time. We used NDVI as a proxy control for the growing conditions of the area during the growing season immediately prior to administration of the DHS survey; it is the average NDVI for December, January, and February prior to DHS implementation (June through November 2010). When vegetation is brown because it is the dry season, or because the climate is unusually dry, the NDVI is low. When the climate is wet, and the grass, trees, and other land cover is green, the NDVI is high. There is 1 NDVI measurement associated with each DHS sampling cluster.

Statistical Methods

We conducted multivariate analyses using unweighted binomial logistic regressions to examine the correlation between our independent variables of interest (forest cover or decadal change in forest cover) and our selected dichotomous outcome variables (severe stunting, dietary diversity, consumption of vitamin-A rich foods, and experience of diarrhea), while controlling for confounding factors for which data were available. Logistic regression does not impose restrictive normality assumptions on predictors. The results are expressed in odds ratios that indicate the associations between the independent and dependent variables without attributing causality.

Only the most recent birth for each mother interviewed was included in the analysis to avoid intra-household correlations in the selected outcomes. The unweighted number of cases contributing to each analysis was as follows: dietary diversity (n=9,166), consumption of vitamin A-rich foods (n=9,166), experience of diarrhea (n=12,831), and stunting (n=3,173).

RESULTS

We found that children living in DHS clusters with a net loss of forest cover over the past decade were 19% less likely to have a diverse diet and 29% less likely to consume vitamin A-rich foods than children living in clusters with no net change in forest cover (Figure 2). These differences were statistically significant.

Conversely, children living in communities with higher percentages of forest cover were more likely to consume vitamin A-rich foods and less likely to experience diarrhea (Figure 3). Children living in clusters with a net gain in forest cover from 2000 to 2010 were 34% less likely to experience diarrhea (P=.002). No statistically significant associations were found between the percentage of forest cover variable and child stunting, but there was a marginally statistically significant association between net gain of forest cover and stunting (P=.058). Odds ratios are presented in the Table.

Children living in areas with a net loss of forest cover were significantly less likely to have a diverse diet and to consume vitamin-A rich foods than children living in areas with no net change in forest cover.

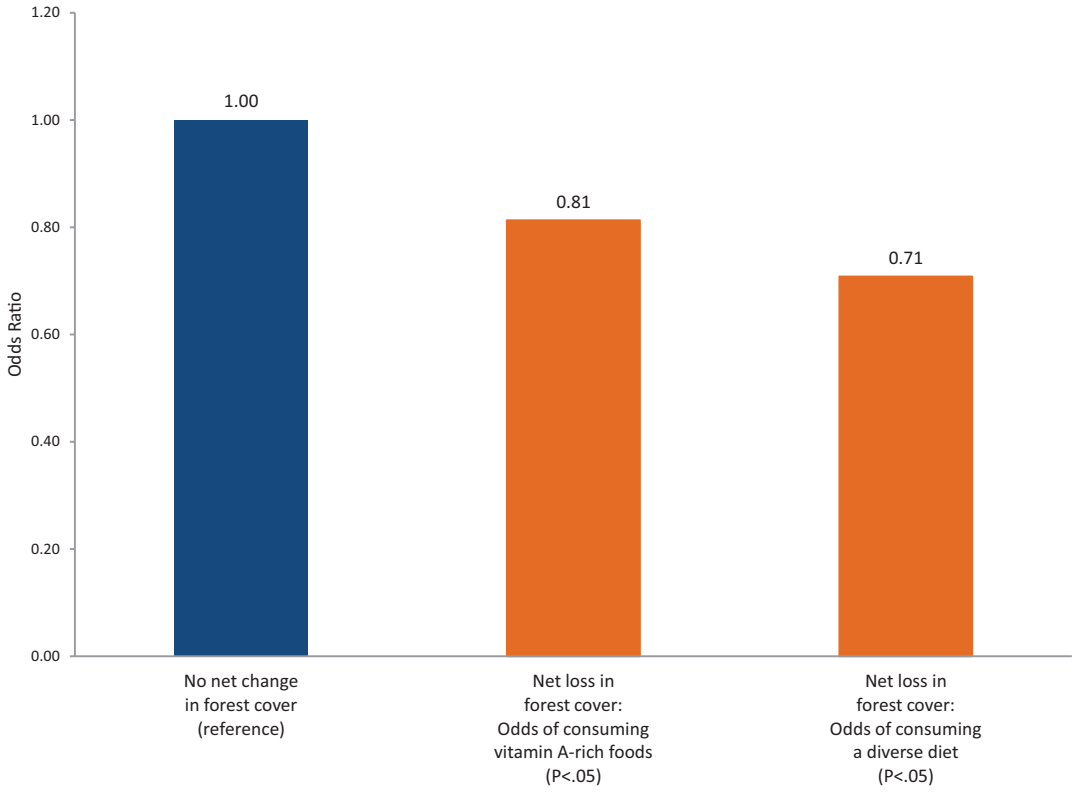
The health and nutrition outcomes we found to be associated with variation in forest cover have serious implications for children's growth and development. Dietary diversity is often used as an indicator of adequate dietary intake of micronutrients.[22] Inadequate intake of vitamin A can lead to deficiency, which is estimated to impact 60% of young children in Malawi.[23] Vitamin A deficiency is associated with poor vision and increased susceptibility to infectious diseases such as malaria and diarrhea, with consequent mortality.[23–24] Diarrhea in children in developing countries is a leading cause of mortality; a recent study estimated that up to 25% of deaths in young children in Africa can be attributable to the disease.[25]

DISCUSSION

Our results demonstrate an association between forest cover and selected nutrition-related outcomes. A study in 3 villages in southern Malawi found that, on average, almost two-thirds of households sampled consumed wild fruit, vegetables, and mushrooms from the forest, and almost one-quarter consumed bushmeat to supplement their diets.[26] Nearly 70% of study participants were dependent on wood collected from forests for cooking.

The dependence of these rural populations on forest products is consistent with our finding that dietary diversity and consumption of vitamin A-rich foods decrease with net decadal loss in forest cover. With respect to increased forest cover over time, we did not find a positive association with dietary diversity, and actually found a marginally significant positive relationship with severe stunting. It is our understanding, based on expert observations from Malawi,

FIGURE 2. Logistic Regression Results: Net Loss of Forest Cover Reduces the Odds That a Child Will Consume Vitamin A-Rich Foods and Have a Diverse Diet



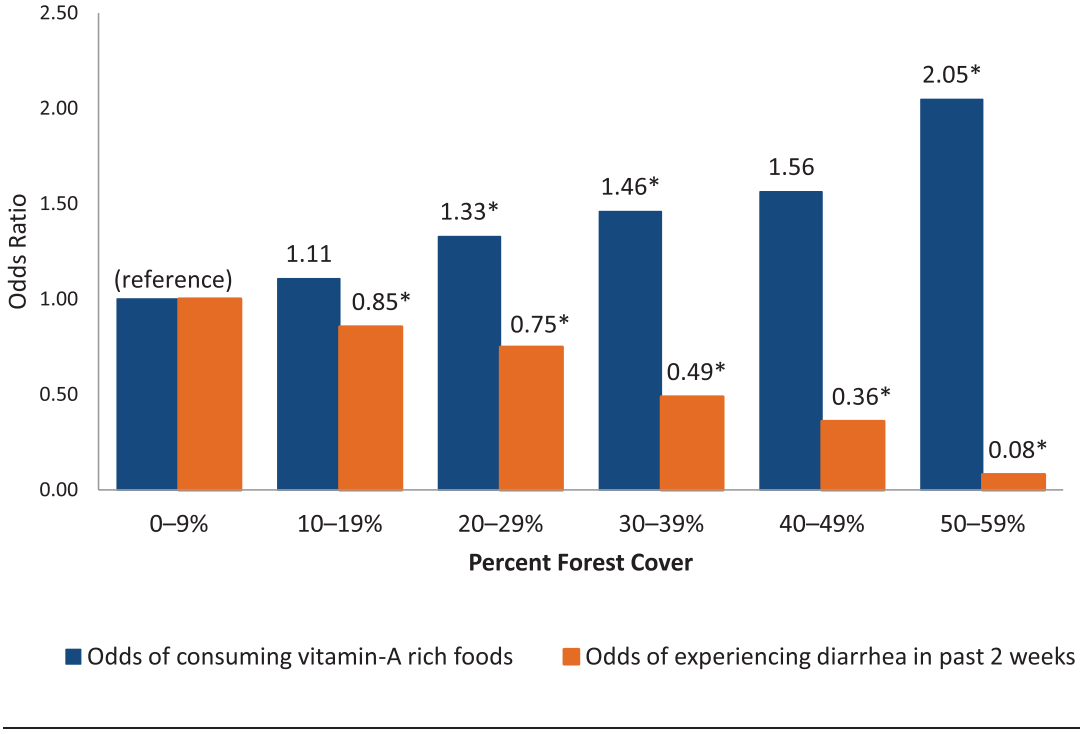
that reforested areas tend to be plantations with monocultures of non-native trees. Such areas may not provide the same diversity of animal and vegetable nutrition as native forests. Additionally, access of local populations to reforested areas tends to be more restricted than to native forests. Such reforested areas usually are privately held (for example, in the case of tea plantations) or strictly controlled by a village committee or individual. In contrast, while native forests are tightly regulated by law, in practice they are heavily accessed and used. Reduction in access to NTFPs from such reforested areas could also lead to poorer nutritional outcomes for nearby communities. Further research is needed to support these hypotheses, however.

Forest cover is significantly associated with reduced child diarrheal disease.

Our results also demonstrate an association between forest cover and reduced child diarrheal disease, supporting the hypothesis that forests play an important provisioning role, specifically in terms of water availability and/or quality, 2 factors that impact diarrheal risk in developing countries.[27] Forests help to maintain healthy watersheds, prevent soil erosion, and filter impurities from water, all of which positively impact water availability and quality.[28] Our finding that an increase in decadal forest cover reduces diarrhea risk suggests that tree plantations, which are the primary source of increasing forest cover in Malawi, may be as effective as older forests with regard to this particular health outcome.

In 2008, the Maternal and Child Undernutrition Study Group estimated that co-exposure of nutrition-related factors, such as vitamin A and iron deficiency, were together responsible for about 35% of child deaths worldwide and for 11% of the total global disease burden.[29] The authors noted that the evidence

FIGURE 3. Logistic Regression Results: Greater Forest Cover Increases the Odds That a Child Will Consume Vitamin A-Rich Foods and Decreases the Odds That the Child Will Experience Diarrhea



* $P<.05$ (statistically significant).

makes a compelling case for the urgent implementation of interventions to reduce the various forms of undernutrition or to ameliorate their consequences.

Our results provide preliminary evidence suggesting that an equitable, sustainable, and effective way to improve child nutrition—and hence, survival—outcomes could include ensuring the integrity of natural ecosystems. Such an integrated approach would result in ecosystems that are healthy enough to deliver the services that local communities depend on, including foods with high nutrient bioavailability and clean water, which is essential in preventing diarrheal disease.

Given the limitations of the currently available data, it was possible to demonstrate only associations, not causal relationships, in this analysis. To establish the causal pathways and mechanisms responsible for the demonstrated associations between forest cover and child health and nutrition outcomes in Malawi, further research is needed, involving collection of accurately geo-referenced, longitudinal population and health data and women's time allocation data, as well as concomitant collection and testing of water samples for quality and use of newly-available 30-meter remote sensing data.

Protecting natural ecosystems could be a sustainable and effective way to improve child nutrition and health.

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TABLE. Logistic Regression Results: Adjusted Odds Ratios for Child Health and Nutrition Outcomes Associated With Forest Cover, Malawi 2010

Forest cover-related independent variables	Severe Stunting[a]				Dietary Diversity[b]				Vitamin A-Rich Foods[b]				Diarrhea[b]			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	P Value	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR	*P* Value	OR
Deforestation, 2000–2010 (ref: no change)	.16				.14		–	–	.002		–	–	.003		–	–
Net loss of forest cover	.64	1.113	–	–	.049	.813	–	–	.003	.708	–	–	.06	.822	–	–
Net gain of forest cover	.058	1.647	–	–	.56	.930	–	–	.16	1.201	–	–	.002	.658	–	–
Forest cover (ref: 0–9%)			.47		–	–	.13		–	–	.01		–	–	<.001	
10–19%	–	–	.58	1.080	–	–	.52	.961	–	–	.13	1.106	–	–	.008	.854
20–29%	–	–	.25	1.283	–	–	.08	1.188	–	–	.006	1.328	–	–	.003	.748
30–39%	–	–	.14	1.665	–	–	.34	1.177	–	–	.03	1.459	–	–	<.001	.487
40–49%	–	–	.58	.700	–	–	.75	.908	–	–	.15	1.562	–	–	.008	.358
50–59%	–	–	–	–	–	–	.08	1.736	–	–	.02	2.046	–	–	<.001	.079

Abbreviations: OR, Odds Ratio.

P values ≤ .05 were considered statistically significant.

[a] Controls included child's age, previous birth interval, mother's education, urban residence, household wealth, migration status, and Normalized Difference Vegetation Index (NDVI).

[b] Controls included child's age, mother's education, urban residence, household wealth, migration status, and NDVI.

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REVIEW

Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability

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Only 34% of hospitals have reliable electricity access in surveyed sub-Saharan African countries. However, analysis in 2 countries indicates modest improvements in electricity access over time. Ambitious plans to improve health service delivery in sub-Saharan Africa need to address this critical issue.

ABSTRACT

Background: Access to electricity is critical to health care delivery and to the overarching goal of universal health coverage. Data on electricity access in health care facilities are rarely collected and have never been reported systematically in a multi-country study. We conducted a systematic review of available national data on electricity access in health care facilities in sub-Saharan Africa.

Methods: We identified publicly-available data from nationally representative facility surveys through a systematic review of articles in PubMed, as well as through websites of development agencies, ministries of health, and national statistics bureaus. To be included in our analysis, data sets had to be collected in or after 2000, be nationally representative of a sub-Saharan African country, cover both public and private health facilities, and include a clear definition of electricity access.

Results: We identified 13 health facility surveys from 11 sub-Saharan African countries that met our inclusion criteria. On average, 26% of health facilities in the surveyed countries reported no access to electricity. Only 28% of health care facilities, on average, had reliable electricity among the 8 countries reporting data. Among 9 countries, an average of 7% of facilities relied solely on a generator. Electricity access in health care facilities increased by 1.5% annually in Kenya between 2004 and 2010, and by 4% annually in Rwanda between 2001 and 2007.

Conclusions: Energy access for health care facilities in sub-Saharan African countries varies considerably. An urgent need exists to improve the geographic coverage, quality, and frequency of data collection on energy access in health care facilities. Standardized tools should be used to collect data on all sources of power and supply reliability. The United Nations Secretary-General's ''Sustainable Energy for All'' initiative provides an opportunity to comprehensively monitor energy access in health care facilities. Such evidence about electricity needs and gaps would optimize use of limited resources, which can help to strengthen health systems.

BACKGROUND

From a health and development perspective, ensuring universal access to modern energy services in health facilities in developing countries is an essential requirement for improving health and well-being. However, evidence about energy access in health care facilities in developing regions is lacking. In 2012, the United Nations (UN) Secretary-General launched the ''Sustainable Energy for All'' (SE4All) initiative, which aims to achieve universal access to clean and modern energy sources in households and community settings by 2030.[1] The initiative also aims to double the global rate of energy efficiency and use of renewable energy. SE4All notes that health care facilities are a special focus on its community energy access agenda; work

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The UN Secretary-General's Sustainable Energy for All initiative aims to achieve universal access to modern energy services by 2030.

Many essential devices used in health care services require significant electricity supply.

has already begun to define measurable access targets for electricity—one of the most widely used forms of energy in health services.

In the health-sector context, a 2012 UN General Assembly resolution defined universal health coverage as a top global priority, urging governments to move toward providing all people with access to affordable, quality health care services.[2] The World Health Organization (WHO) defines access to essential medicines and technologies as 1 of the 4 key factors to ensuring universal health coverage.[3] Many of these ''essential technologies'' require electricity, and without electricity, many health care interventions simply cannot be provided.

Although there is no unified matrix of electrical devices required for all essential health care services, access to electricity is an implicit or explicit concern of recent assessments on available technologies.[4] For instance, a recent UN interagency list of essential medical devices for reproductive health specifically denotes those devices that require access to electricity (Table 1).[5]

Initiatives to expand capacity in developing countries to prevent and treat noncommunicable diseases also are placing increased emphasis on the essential devices required, such as electrocardiograms and mammograms, most of which require significant electricity supply capacity.[6] Immunization policy also faces an energy challenge: WHO has projected that vaccine refrigeration capacity needs to expand 8- to 10-fold by 2025 to meet the vaccine needs of a growing global population.[7]

Even when not an outright barrier to services, presence of electricity can improve the range of potential primary care interventions.

TABLE 1. UN Interagency List of Essential Devices for Reproductive Health Requiring Electricity

Essential Devices	First-Level Clinic	Referral-Level Facility (Non-Hospital)
Doppler	✓	✓
Scanner, ultrasound		✓
Sterilizer, steam ~24–40 L	✓	
Sterilizer, steam ~39–100 L		✓
Vacuum extractor[a]		✓
Breast pump[a]		✓
Anesthesia/Resuscitation Equipment		
Free-standing anesthesia system		✓
Newborn incubator		✓
Patient monitor		✓
Nebulizer, atomizer, with electric compressor		✓
Phototherapy unit		✓
Pulse oximeter portable unit		✓
Resuscitation table (newborn)		✓
Resuscitation ventilator (adult/child)		✓
Electric baby warmer	✓	

Facility appliances, such as electric lights, communication equipment, water pumps, and refrigeration, are not included in the table.

[a] Manual version sometimes available.

Source: Adapted from the ''Interagency List of Essential Medical Devices for Reproductive Health.''[5]

Anecdotal evidence and findings from a country assessment[8] indicate that, in developing countries, electricity access in health care facilities is partial and unreliable. However, trends and patterns have not been compared systematically across countries or in regions.

Establishing electricity access profiles of health care facilities in developing countries can identify settings where lack of electricity may be a severe and underreported barrier to effective health care delivery. Better data can inform innovations in the health and energy sectors, as well as direct investments in areas with greatest need. They also can document progress in closing energy gaps that may create a ''silent barrier'' to accessing health services, particularly for poor and vulnerable populations. Such benchmarking and monitoring is relevant not only to universal health coverage but also to better integration of health-sector issues into sustainable development goals and targets. This systematic review and analysis aims to expand our knowledge and understanding of the state of electricity access in health facilities of developing countries.

METHODS

Data Sources and Search Strategy

We reviewed available data on electricity access from websites dedicated to assessing health facility equipment, including:

- Service Provision Assessment (SPA) implemented under the MEASURE Demographic and Health Survey program, supported by the U.S. Agency for International Development (USAID)[9]
- A similar WHO tool, called Service Availability Mapping (SAM)[10]
- A more recent tool, the Service Availability and Readiness Assessment (SARA), developed jointly between WHO and USAID, which aims to harmonize diverse approaches to facility assessment[11]

We also searched the websites of the International Health Facility Assessment Network (IHFAN) and the Global Fund to Fight AIDS, Tuberculosis and Malaria (for their Technical Evaluation surveys).[12–13] From these websites, we identified a cluster of nationally representative facility data sets from sub-Saharan Africa. Outside sub-Saharan Africa, we found nationally representative data sets for only 3 developing countries (Bangladesh, Egypt, and Guyana).

As a result, we narrowed our systematic literature review to sub-Saharan African countries and searched PubMed using the following search terms: (health facilities (MeSH) OR health facilities OR (health AND facilities) OR (health AND care AND facilities) OR health care facilities) AND (survey OR data collection (MeSH) OR data collection OR (data AND collection)) AND (electricity (MeSH) OR electricity). We also searched the Ministry of Health (MOH) and National Bureau of Statistics (NBS) websites of 46 sub-Saharan African countries. No time frame was specified in the searches. For one of the countries (Liberia), we obtained permission directly from the Ministry of Health and Social Welfare to review national data being analyzed in the context of a donor-supported study on electrification and maternal and newborn service delivery.[14]

Data Inclusion Criteria

For inclusion, a study and/or the data set had to meet all of the following criteria:

1. Collected in or after 2000
2. Nationally representative of a sub-Saharan African country
3. Covers both public and private health care facilities
4. Includes a clear definition of ''access to electricity'' and description of how it was assessed

If a study or data set met the inclusion criteria but the raw data were not publicly available, we attempted to contact the corresponding author or surveying agency to obtain the data. Obtaining raw data allowed us to extract the information systematically, based on consistent assumptions and indicator definitions. In the case of Nigeria and The Gambia, where raw data were not obtained, we used reported data, insofar as clear definitions of indicators were stated and aligned with this study's variable definitions.

Definitions and Parameters of Energy Indicators

While surveys administered by different agencies and in different countries usually contained similar types of questions, they were far from harmonized tools. Subtle but often significant inconsistencies in actual survey questions

administered by different countries reflect the lack of a clear and universal set of indicators of health facilities' electricity access. For the purposes of this analysis, we therefore conducted an initial mapping of the types of survey questions most commonly posed, grouping them thematically into a typology of access issues (see supplementary Appendix Table). This close examination of individual survey questions also allowed for systematic consideration of a second critical issue: defining which survey questions, or combination of questions, from different country surveys could be directly compared in various aspects of the data analysis.

We defined 3 key electricity indicators covered in the surveys, which we analyzed in this review:

1. **Electricity Access:** A facility using, at least *some* of the time, any source of electrical power (yes or no). Facilities that reported a generator as their only source of electricity were classified as not having access to electricity if they reported that the generator was not functioning.
2. **Source of Electricity:** (1) Generator only, or (2) central supply, solar, or other source.
3. **Reliable Electricity:** Power available during all regular service hours, with no outages exceeding 2 hours on a given day in the week prior to data collection.

We disaggregate this data for 2 key categories of health facilities: ''hospitals'' providing tertiary care and ''all other'' facilities. Further disaggregation was confounded by the lack of clear definitions across countries of ''primary'' and ''second-tier'' facilities.

Statistical Analysis

When raw data sets were available, we used the statistical software Stata (version 12) to extract country-level estimates for electricity access, source of electricity, and reliability of electricity. We applied sample weights, when available, to derive summary descriptive statistics (means) for individual countries. We derived 2 sets of estimates for each country data set: one at an aggregate level, which included all facilities in a country, and the other facility type (''hospital'' and ''other facilities'').

In cases where an overall mean value for a given variable (for example, access to electricity) for a type of facility is presented in our analysis, it was a simple average of the individual country averages for that variable in that facility type; we did not apply further weighting methods (for example, weighting by population). In cases where multiple surveys were available for an individual country, we used the most recent survey to derive multi-country means for a variable.

For countries with 2 years of survey data, we conducted a limited trend analysis by dividing the change in the percentage of facilities with electricity access by the number of years between surveys. Although different facilities were likely to have been assessed in the different survey years, we presumed the change in electrification was reflective of a general national trend since the surveys involved nationally representative samples of health facilities and used the same survey tool.

RESULTS

Study Selection

A total of 13 health facility assessments from 11 countries met the inclusion criteria, covering a time frame of 11 years (2001 to 2012). For 2 countries, we identified studies from 2 different years: Kenya (2004, 2010)[15–16] and Rwanda (2001, 2007).[17–18] In these cases, we used the most recent data for most aspects of the analysis but considered data from both years to analyze trends.

We identified the included data sets as follows: The PubMed literature search returned 115 publications; we reviewed every abstract in its entirety and fully reviewed 10 publications. Of these, 3 publications met the inclusion criteria and were included in our analysis (Ethiopia, The Gambia, and Nigeria).[19–21] The studies for Ethiopia and Nigeria focused specifically on electricity access for facilities providing emergency obstetric and newborn care services. We also obtained nationally representative data for another 8 countries (Ghana, Kenya, Namibia, Rwanda, Sierra Leone, Tanzania, Uganda, and Zambia) by searching dedicated websites, including the SPA and SARA.[15,17,22–27] Our search of the sub-Saharan African NBS and MOH websites failed to identify any data meeting the inclusion criteria. Four NBS websites and one MOH website were not functioning or could not be accessed due to security restrictions. The Liberian Ministry of Health data included surveys of virtually all public facilities for the years 2011

and 2012 but not of private facilities; as a result, we consider the data in a case study.[28–29]

The Technical Evaluation surveys from the Global Fund and the SAM surveys from WHO included data on electricity access, but they were not nationally representative and thus were excluded from our analysis. In addition, certain data collection methods in these 2 surveys were less consistent or robust than in other surveys; for example, the 2 surveys relied on district officers to report the percentage of facilities with electricity access compared with onsite interviewing methods used by other surveys.

Study Characteristics

All 11 country surveys provided comparable data on *electricity access*. Survey data from 9 countries reported the *source of electricity*. In 4 of the countries (Kenya, Namibia, Sierra Leone, and Uganda), survey questions more clearly and reliably articulated the choices of solar sources used alone or in combination with other sources. For these 4 countries, we performed limited sub-analyses to explore the use of solar power in health facilities. A total of 8 surveys yielded data on *reliability of electricity supply* (Table 2). Some surveys did not specify a time frame for electricity outages while others asked about availability of electricity on the day of the survey.

Electricity Access

On average, 74% of facilities had access to electricity (Table 3) (range=42% to 100%). There were substantial differences in the degree of electricity access for hospitals compared with ''other'' facilities. For hospitals, 94% to 100% of facilities had access to electricity. For ''other'' facilities, only 72% of facilities, on average, had access to electricity across the 11 countries.

Source of Electricity

The proportion of facilities relying on only a generator for electricity ranged from an average of only 1% of facilities in Uganda and Zambia to 33% in The Gambia, yielding a mean of 7% across 9 countries. By facility type, an average of 6% of hospitals and 8% of ''other'' health facilities reported generators as their only source of power (Table 3). Hospitals and other facilities in The Gambia reported higher reliance on generators as their only source of power than facilities in any other country. Excluding The Gambia, 4% of all facilities, on average, relied on only generators for electricity.

In Kenya, Namibia, and Uganda, surveys asked whether a combination of central and solar sources were used. Notably, in Uganda, approximately 15% of hospitals and almost 2% of other health facilities reported using a combination of both central and solar sources. In comparison, in Kenya and Namibia, less than 3% of hospitals and less than 1% of other health facilities reported energy from a combination of solar and central supply sources.

Solar energy sources are growing in popularity. In Uganda, 15% of hospitals use both central and solar sources.

Unlike other surveys, the SARA survey of Sierra Leone asked facilities to report all sources of electricity. No distinction was made, however, between primary and secondary or backup sources, so responses add up to more than 100% for all source categories. However, results do reflect the widespread presence of solar systems, along with more conventional generator and grid sources (Table 4). Across all facilities, over one-third received some power from solar, over one-quarter from a generator, and over one-tenth from a central grid supply. Almost all hospitals reported using a generator for power, and just over half reported having a central supply.

Reliability of Supply

On average, only 28% of all facilities with electricity access reported reliable access (Table 3) (range=15% to 49%). Among hospitals, 34%, on average, reported reliable electricity access (range=16% to 64%) compared with 26% for other health facilities (range=14% to 47%). A sub-analysis of 6 countries where generator functionality was assessed by SPA surveys found that, among facilities with generators, a low proportion (10% to 29%) reported having functional generators with fuel available at the time of the assessment.

Only 34% of hospitals in sub-Saharan Africa, on average, have reliable electricity access.

Trends in Countries Over Time

On average, electricity access increased annually by 1.5% in Kenya and by 4% in Rwanda in the years between the two studies (Table 5). At the end of the periods studied, a much higher proportion of hospital facilities continued to have electricity access than the proportion of ''other'' facilities. However, those ''other,'' non-hospital facilities had made greater progress, on average, in providing electricity access.

In Kenya, electricity access increased annually in other facilities by 1.5%, and in

TABLE 2. Electricity Access for Health Care Facilities in Selected sub-Saharan African Countries, by Facility Type

Country, Year (No. of Facilities)	Percentage With: No Electricity	Generator Only	Central, Solar, or Other Supply[a]	Reliable Electricity
Ethiopia, 2008 (N=797)[20]				
All facilities	14	5	81	–
Hospital	1	2	96	–
Other facilities	15	6	79	–
The Gambia, 2004 (N=12)[19]				
All facilities	0	33	67	25
Hospital	0	20	80	40
Other facilities	0	43	57	14
Ghana, 2002 (N=428)[22]				
All facilities	31	–	–	–
Hospital	6	–	–	–
Other facilities	34	–	–	–
Kenya, 2010 (N=695)[15]				
All facilities	26	2	72	15
Hospital	2	2	96	24
Other facilities	28	2	70	14
Namibia, 2009 (N=411)[23]				
All facilities	4	1	94	49
Hospital	0	0	100	64
Other facilities	5	2	93	47
Nigeria, 2011 (N=121)[21]				
All facilities	30	–	–	–
Hospital	0	–	–	–
Other facilities	32	–	–	–
Rwanda, 2007 (N=538)[17]				
All facilities	18	6	76	41
Hospital	2	10	88	52
Other facilities	19	5	75	40
Sierra Leone, 2011 (N=106)[27]				
All facilities	35	10	54	14
Hospital	0	4	96	23
Other facilities	37	10	53	14
Tanzania, 2006 (N=611)[24]				
All facilities	50	2	47	19
Hospital	2	6	92	23
Other facilities	52	2	45	19
Uganda, 2007 (N=491)[25]				
All facilities	58	1	41	15
Hospital	1	5	94	16
Other facilities	60	1	38	15
Zambia, 2005 (N=430)[26]				
All facilities	20	1	78	46
Hospital	2	7	92	33
Other facilities	21	1	78	47

Because of rounding, the sum of the percentages in the first 3 columns (no electricity, generator only, and central, solar, or other supply) may not total 100.

[a] Includes facilities that reported use of a combination of multiple power sources (for example, central supply and generator).

TABLE 3. Energy Access Among Health Care Facilities (Mean), by Facility Type, Selected sub-Saharan African Countries[a]

	Facility Type		
Energy Access	**All Facilities**	**Hospitals Only**	**Other Facilities Besides Hospitals**
Access to electricity, %	74	99	72
(N=11 countries)			
Source of electricity, %			
(N=9 countries)			
Generator only	7	6	8
Central, solar, or other	68	93	65
Reliable electricity, % of electrified facilities	28	34	26
(N=8 countries)			

[a] Data for access to electricity are averages among 11 countries (Ethiopia, The Gambia, Ghana, Kenya, Namibia, Nigeria, Rwanda, Sierra Leone, Tanzania, Uganda, and Zambia); for source of electricity, among 9 countries (excludes Ghana and Nigeria); and for reliable electricity, among 8 countries (excludes Ethiopia, Ghana, and Nigeria).

TABLE 4. Source of Electricity for Health Care Facilities, by Type of Facility, Sierra Leone, 2012

	Facility Type		
Electricity Source	**All Facilities**	**Hospitals Only**	**Other Facilities Besides Hospitals**
Central grid, %	13	58	12
Generator, %	25	95	22
Solar system, %	36	43	36
Other,[a] %	15	21	15

The total sum of sources for a particular type of facility do not add up to 100% because each facility could report more than one electricity source.

[a] Flashlights were the most typical response for ''other'' sources of electricity, reflecting a blurring of the lines between actual electricity sources and specific devices, which needs refinement in future surveys.

Rwanda by 5% annually, compared with 0% and 1%, respectively, in hospitals.

DISCUSSION

This analysis frames some of the key issues and challenges faced in defining and measuring electricity access in health facilities in developing countries. It also provides initial baseline data on electricity access in 11 sub-Saharan African countries. On average, over one-quarter of all health care facilities lacked any access to electricity, and close to three-quarters lacked access to a reliable supply of electricity. Although these data represent only about one-quarter of sub-Saharan African nations, they include 6 of the 10 most populous countries (Nigeria, Ethiopia, Tanzania, Kenya, Uganda, Ghana).

These findings reflect the significant energy insecurity not only at the primary care level but also in hospitals—the highest tiers of health care provision. These results also reveal the important

In sub-Saharan Africa, even the highest tiers of health care—hospitals—have significant energy insecurity.

TABLE 5. Trends in Electricity Access in Health Care Facilities, by Facility Type, Kenya and Rwanda

Country and Year	All Facilities		Hospitals Only		Other Facilities Besides Hospitals	
	Percentage	Annual Percentage Change	Percentage	Annual Percentage Change	Percentage	Annual Percentage Change
Kenya						
2004	65	1.5	98	0	63	1.5
2010	74		98		72	
Rwanda						
2001	58	4	92	1	52	5
2007	82		98		81	

role that generators have in powering health facilities in some sub-Saharan African countries, while at the same time reflecting their unreliability, evident in the high proportion of facilities reporting generators not functioning or lacking fuel.

On the positive side, the results of the limited time-trend analysis illustrate that rapid progress can be achieved in improving the energy access situation in health care facilities. For example, in Rwanda, where the change was most marked, the percentage of all facilities with access to electricity rose from 52% in 2001 to 82% in 2007. Data from countries such as Liberia, Sierra Leone, and Uganda also illustrate the growing importance of solar electricity sources in health facilities, both as a stand-alone source and in combination with generators or grid supply.

Better Measurement Needed to Inform Energy Policymaking

Analysis of these data are an initial, but significant, step in proposing parameters for defining key electricity access indicators for health facilities, which may be useful in identifying gaps and monitoring trends. This is a timely endeavor in the context of both the UN SE4All initiative and the parallel aspiration of universal health coverage.

WHO and its partners already are initiating moves to improve methods for tracking electricity access, its reliability, and the growing diversity of energy sources. An initial step has been to refine and slightly expand the electricity questions in the SARA to capture a broader spectrum of the available primary and secondary electricity sources and to better measure power reliability and capacity. WHO is currently piloting this revised survey section in several countries.

This review also has highlighted the need for a broader interagency effort to advance a framework to measure uniformly and fully the diverse dimensions of sustainable energy access in health facilities. Key institutions managing facility surveys, as well as Ministries of Health and energy experts, need to work together to identify and harmonize the best survey questions and electricity indicators relevant to actual delivery of health services. Such a framework could contribute to the development of more comprehensive, routine, global energy assessments of health care facilities by WHO and its partners, as well as by national ministries of health, to support joint health sector and SE4All monitoring and reporting of energy access in health facilities. In April 2012, the SE4All Initiative announced a new ''high-impact opportunity'' related to energy and women's health, which focuses additional attention on the urgent need to improve electricity access to medical clinics; such political momentum may help push forward the technical initiatives.[30]

Survey Coverage

Broader geographic coverage of electricity access data also is clearly needed to obtain a global

picture of electricity access in health care settings. Similarly, disaggregation of data by urban and rural communities and by socioeconomic setting would help identify areas of greatest need and the most vulnerable populations.

Variables of Interest

Since facilities in some of the surveyed countries rely on off-grid energy sources, better assessment by energy source and by combinations of sources is critical to forecasting needs and identifying optimal energy solutions in diverse settings. Current survey questions about reliability of electricity service ''during normal business hours'' are inherently self-limiting because health facilities are more likely to close at night if they do not have access to electricity. Indicators capturing the duration of electricity supply during evening hours or throughout the day and night may be important to the extent that electricity access may also be an enabler of nighttime services, emergency services, or longer service hours generally.[16,31–32] Finally, since the power demands of different facility types can vary considerably, certain other power attributes of the supply, such as capacity in terms of total watt hours or kilowatt hours available daily, could be another variable needing better assessment.

Changing Landscape of Electricity Source

The cost of renewable technologies has declined sharply in the past decade.[33] At the same time, average global oil prices have increased, making fossil fuels for off-grid health clinics increasingly expensive and difficult to access,[33] as reflected in the low proportion of functional generators in surveyed facilities. Small solar power facilities are becoming more affordable, and their costs can be lower than that of fossil fuel generators over time. These factors are paving the way for small-scale solar applications suited to highly resource-constrained settings.[34–35]

The Liberia case study reflects this changing landscape (Box). In 2012, more public primary health clinics were using solar power systems (146) than fossil fuel generators (116). About 4 clinics in every 5 that relied on solar power as their primary energy source reported having electricity available on the day of the survey compared with only about half of the clinics that relied on diesel generators as their primary electricity source.

Study Limitations

Discrepancies in survey questions created barriers to consistent multi-country analysis, accounting for variation in the number of countries covered in elements of the sub-analysis. For the 2 countries where we assessed trends over time, questionnaire inconsistencies for different years limited our analysis to a single indicator (electricity access).

Assessment of electricity access at different levels of health facilities was limited by the lack of comparable definitions for primary, secondary, and tertiary facilities. Facility classification names were inconsistent and types of care at different levels were not clearly defined in terms of the facility categories used by individual countries. For example, some surveys referred to health centers, health posts, and dispensaries, whereas others referred to Health Center I, Health Center II, and so forth. Rather than aiming for complete uniformity, future survey models should consider ways to classify the different types of facilities in any given country by 3 key service tiers (primary, secondary, and tertiary), so that multicountry data may be analyzed and reported accordingly.

Another limitation was in facility sampling methods; while nationally representative of different facility categories, methods used to select the sample were not uniform. In some countries, sampling focused only on those facilities offering ''priority'' interventions while others sampled all health facilities.

CONCLUSIONS

As far as the authors can determine, this is the first multicountry analysis of electricity access in health facilities presented in the peer-reviewed literature. The data reflect a reality described anecdotally by health care workers as operating, quite literally, ''in the dark,'' forced to rely on the most minimal sources of light such as flashlights or polluting and dangerous kerosene lamps.[37] Although we have not estimated the impact in terms of health, disability, and loss of life, we presume the impact is significant. Further stratification of electricity access data by urban-rural areas and by socioeconomic setting would be useful, but in light of other health service inequities, as well as anecdotal evidence, it is likely that poor and vulnerable groups suffer the most from lack of access to electricity.[8]

BOX. Liberia Case Study: Improved Electricity Access and Reliability Through Off-Grid Power Sources

Since 2011, the Liberian Ministry of Health and Social Welfare has conducted regular infrastructure surveys, which include electricity indicators, for all government health care facilities. The data sets, covering all public facilities, are some of the most recent considered in this study, and are available for 2 consecutive years (N=376 facilities in 2011; N= 381 in 2012).[28–29] However, since approximately 200 private facilities were not included, we excluded the Liberia data sets from our larger 11-country analysis.

Still, this case study is relevant for 3 reasons:

- Public facilities may be more representative of health care access by the broader population. Some country-based reviews also suggest that public facilities may have less electricity access or use than private counterparts, making them worthy of separate consideration.[8]
- The Liberia surveys covered both primary and backup electricity sources with 6 distinct response options: community-shared, generator, solar power, other, none, lamp/torch. (For the purpose of our analysis, we considered ''lamp/torch'' as ''none.'') Responses also could be categorized by 3 levels of service provision: first-level health clinics, health centers, and hospitals.
- Both 2011 and 2012 surveys included a question on the reliability of electricity access, although the question was posed slightly differently each year. In 2011, the survey asked, ''Is electricity available during all required operational hours?'' In 2012, it asked, ''On the day of assessment, was electricity available at the facility?''

This permitted some initial analysis of electricity access relative to different off-grid electricity sources (generators, solar)—an issue relevant to many parts of Africa, and particularly to Liberia, where off-grid electricity is the norm.[36]

The proportion of Liberian facilities reporting electricity access of some kind increased from 54% in 2011 to 62% in 2012. Most of this increase was due to acquisition of either generators or photovoltaic (PV) solar systems. At the health clinic level, there were more facilities reporting solar systems as their primary electricity source (146) than facilities reporting generators (116) in 2012. However, generators remained more common among second-tier health centers. In 2012, a handful of facilities had connected to a community/shared source (often as a backup source), although grid connections remained rare. All hospitals reported generators as their primary electricity source in both years.

The data suggest a higher level of reliable electricity service for primary health clinics using solar-powered systems as their primary source than for those relying on generators (Table 6[1]). This was irrespective of the ''secondary'' source of electricity, if any was available. Although there are many confounding factors that require further exploration, this finding suggests that solar power might be a more reliable electricity source than generators for remote health facilities. Further assessment is needed, however, to consider the technology-specific limiting factors (for example, fuel supply and maintenance logistics for generators as compared to, weather variability, and power capacity for small, affordable PV solar systems). For instance, in Liberia PV solar systems were reported to be more frequently used for dedicated devices and low-power applications, such as lighting and refrigeration, rather than as power for the entire facility (personal communication with Elaine Fletcher and Annette Kuesel, Data Managers, Liberia Institute for Biomedical Research, 2012).

The Liberia MoHSW surveys show, however, that it is feasible to conduct routine, national-level collection of data on electricity access, and offers models of survey questions that can help inform more robust data collection tools, including tools that are more sensitive to alternative energy sources. Capturing the full range of energy technologies now being used in terms of how well they function, how much power they generate, and for what purposes each technology is best suited can inform policies for improving health services through energy access. Such analysis can highlight the comparative advantages of different energy choices in diverse settings and identify barriers to scale up of clean, renewable energy options.

Access to more reliable, cleaner, and more sustainable energy sources is increasingly important in light of these realities as well as other economic, environmental, and climate realities. There is thus an urgent need to improve the geographic coverage, quality, and frequency of data collection on energy access in health care facilities.

With a more comprehensive and standardized tracking system, countries will be able to monitor progress toward powering health facilities and its impacts on health and development,

TABLE 6. Reliability of Electricity in Electrified Facilities, by Facility Type and Primary Electricity Source, Liberia, 2011-2012

Facility Type and Primary Electricity Source	Electrified Facilities Reporting Reliable Electricity Access[a]	
	2011	2012
	n/N (%)	n/N (%)
Hospital		
Generator	16/18 (89%)	118/20 (90%)
Community/ shared	1/1 (100%)	1/1(100%)
Health center		
Generator	13/14 (93%)	13/20 (65%)
Solar	10/14 (71%)	5/6 (83%)
Community/shared	–	1/1 (100%)
Health clinic		
Generator	59/100 (59%)	61/116 (52%)
Solar	99/109 (91%)	119/146 (81%)
Community/shared	1/1 (100%)	3/3 (100%)

Data are among all public health facilities but not private facilities.
[a] The 2011 survey defined reliability by whether electricity was available ''during all required operational hours,'' whereas the 2012 survey asked whether electricity was available ''on the day of the survey.''

forecast future energy needs, better allocate limited resources, and share experiences with new and innovative energy solutions.

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METHODOLOGY

Operations research to add postpartum family planning to maternal and neonatal health to improve birth spacing in Sylhet District, Bangladesh

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This quasi-experimental study integrated family planning, including the Lactational Amenorrhea Method, into community-based maternal and newborn health care and encouraged transition to other modern methods after 6 months to increase birth-to-pregnancy intervals. Community-based distribution of pills, condoms, and injectables, and referral for clinical methods, was added to meet women's demand.

ABSTRACT

Background: Short birth intervals are associated with increased risk of adverse maternal and neonatal health (MNH) outcomes. Improving postpartum contraceptive use is an important programmatic strategy to improve the health and well-being of women, newborns, and children. This article documents the intervention package and evaluation design of a study conducted in a rural district of Bangladesh to evaluate the effects of an integrated, community-based MNH and postpartum family planning program on contraceptive use and birth-interval lengths.

Intervention: The study integrated family planning counseling within 5 community health worker (CHW)-household visits to pregnant and postpartum women, while a community mobilizer (CM) led community meetings on the importance of postpartum family planning and pregnancy spacing for maternal and child health. The CM and the CHWs emphasized 3 messages: (1) Use of the Lactational Amenorrhea Method (LAM) during the first 6 months postpartum and transition to another modern contraceptive method; (2) Exclusive, rather than fully or nearly fully, breastfeeding to support LAM effectiveness and good infant breastfeeding practices; (3) Use of a modern contraceptive method after a live birth for at least 24 months before attempting another pregnancy (a birth-to-birth interval of about 3 years) to support improved infant health and nutrition. CHWs provided only family planning counseling in the original study design, but we later added community-based distribution of methods, and referrals for clinical methods, to meet women's demand.

Methods: Using a quasi-experimental design, and relying primarily on pre/post-household surveys, we selected pregnant women from 4 unions to receive the intervention (n=2,280) and pregnant women from 4 other unions (n=2,290) to serve as the comparison group. Enrollment occurred between 2007 and 2009, and data collection ended in January 2013.

Preliminary Results: Formative research showed that women and their family members generally did not perceive birth spacing as a priority, and most recently delivered women were not using contraception. At baseline, women in the intervention and comparison groups were similar in terms of age, husband's education, religion, and parity. CHWs visited over 90% of women in both intervention and comparison groups during pregnancy and the first 3 months postpartum.

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Discussion: This article provides helpful intervention-design details for program managers intending to add postpartum family planning services to community-based MNH programs. Outcomes of the intervention will be reported in a future paper. Preliminary findings indicate that the package of 5 CHW visits was feasible and did not compromise worker performance. Adding doorstep delivery of contraceptives to the intervention package may enhance impact.

BACKGROUND

During the last several decades, global family planning programs have contributed to an increase in contraceptive prevalence and to a decrease in total fertility rates (TFRs) worldwide.[1] In Bangladesh, family planning programs have contributed to a decline in the TFR between 1975 and 2007, from 6.3 to 2.7 children per woman.[2–3] The country was often cited as a family planning success story in the 1990s for improving contraceptive prevalence, from 3% in 1971 to 40% by 1991.[4–5] Currently, 52% of married women in Bangladesh use any modern contraception.[6]

Promoting contraceptive use immediately after birth is considered an important programmatic strategy, but it remains a major challenge. The Population Council first launched a global postpartum family planning program in 1966,[7] implemented largely through hospitals because most contraceptive methods available at that time were clinic-based (notably, IUDs and sterilization). The vast majority of women in developing countries, however, were delivering at home. Thus, the program failed to reach the critical mass required for its success, and it officially ended in 1974. More recently, the World Health Organization (WHO), the U.S. Agency for International Development (USAID), and other partners have issued a joint statement for collective action emphasizing that programs should ''prioritize reaching postpartum women, the group of women with the greatest unmet need for family planning.''[8]

Many family planning programs historically have focused on improving access to family planning and on changing people's attitudes about ideal family size and reducing the TFR, rather than on promoting longer birth intervals. In low-income countries, approximately 57% of second and higher-order births occur at intervals shorter than 3 years, and, in some countries, these conditions have not changed in 20 years.[9]

Consistent observational data from many settings suggest that birth-to-pregnancy intervals shorter than 24 months (equivalent to birth-to-birth intervals of 33 months, or about 3 years) are associated with increased risk of poor maternal, perinatal, and neonatal health outcomes, including increased risk of stillbirth, prematurity, low birth weight, and neonatal mortality.[10–14] Studies in Bangladesh specifically have found that pregnancy intervals shorter than 36 months are associated with a 37% increased risk of late neonatal mortality and 23% increased risk of child mortality, relative to intervals of 36–59 months.[15] In addition, birth-to-pregnancy intervals of 15–75 months are associated with a lower likelihood of fetal loss than intervals greater than 75 months or shorter than 15 months.[16] With respect to women's health, studies in Bangladesh have found that, after adjustment, birth-to-pregnancy intervals shorter than 6 months are associated with increased risk of pre-eclampsia, as well as a 7.5-fold increased risk of induced abortion and a 3.3-fold increased risk of miscarriage, compared with intervals of 27–50 months.[16–17]

Policymakers have called for better integration of family planning services with maternal and child health programs,[18–19] but notable challenges exist in attaining this goal.[20] For instance, in Bangladesh, the Ministry of Health and Family Welfare has separate divisions for ''Health Services'' and ''Family Planning'' with separate directorates and cadres of workers, complicating efforts to integrate services.[21]

A 2012 Cochrane review did not find any integrated family planning and maternal, newborn, and child health program in a developing country that had operationalized the growing evidence on the role of family planning in improving child and maternal health (by strengthening counseling on the benefits of longer birth-to-pregnancy intervals, for example).[22] Although the review noted that improvements in mortality and morbidity outcomes did occur in some integrated programs, the studies did not document clearly the implementation and program design details.

Short birth intervals are associated with poor maternal and newborn health outcomes.

In this article, we describe the intervention package and evaluation design of an operations research study that is nearing completion, called

the Healthy Fertility Study (HFS). The study integrated postpartum family planning education and services within an existing community-based maternal and neonatal health (MNH) program, called ''Projahnmo'' (Project for Advancing the Health of Newborns and Mothers), to improve contraceptive knowledge and practices and birth spacing, focusing specifically on using the Lactational Amenorrhea Method (LAM) during the first 6 months postpartum and transitioning to another modern method afterward. Projahnmo uses female community health workers (CHWs) to deliver MNH services through home visits, complemented by community mobilization activities. The Projahnmo program reduced neonatal mortality by 34% in its first 30 months of implementation in Sylhet district, located in the Sylhet division of rural, northeastern Bangladesh.[23] HFS targeted family planning services to pregnant and postpartum women because studies have found that two-thirds of women who are within 1 year of their last birth have an unmet need for family planning.[24]

Many postpartum women have an unmet need for family planning.

STUDY AREA

We chose to conduct the study in Sylhet division because it had the highest neonatal, infant, and under-5 child mortality rates among the 7 divisions of Bangladesh.[3] In addition, at the time of the design, the division ranked poorly on indicators related to contraceptive use and fertility reduction,[3] including:

- TFR of 3.7 compared with 2.7 for Bangladesh overall
- Unmet need for contraception of 26% compared with 17% for Bangladesh overall
- 57% of second and higher-order births occurred less than 36 months after the preceding birth compared with 37% for Bangladesh overall

Nonetheless, the presence of government-run health and family planning facilities and exposure to family planning messages in the media in Sylhet division are comparable with other parts of Bangladesh. However, women's access to clinical family planning services in Sylhet district is severely constrained. One-quarter of the public-sector positions slated for provision of clinical family planning services are unfilled (personal communication with Mr. Kutub Uddin, Divisional Director of Family Planning, Sylhet Division, Ministry of Health and Family Welfare, Aug 2012). When clinical family planning services are available, they are offered only at specific times during the week. Nongovernmental and private-sector providers also largely lack clinical skills in family planning. Equally important, in Sylhet, cultural norms restrict women from leaving their homes without a chaperone.

INTERVENTION DESCRIPTION

Formative Research to Design Service Delivery Strategies

We conducted formative research between January 2006 and June 2006 to inform the intervention design for postpartum family planning service delivery. Formative research activities included:

- 80 unstructured, in-depth interviews with household members (mothers of children ages 6–23 months with a preceding birth interval longer than 36 months or shorter than 18 months, husbands of these mothers, and elder women living in the home, usually mothers-in-law) to elicit information on birth spacing, timing of first birth, contraceptive practices, and other issues related to healthy fertility
- 40 semi-structured interviews with mothers who practice and who do not practice birth spacing and their mothers-in-law, using free-listing exercises in which participants listed the benefits of birth spacing and risks associated with short birth intervals
- 6 focus groups with mapping exercises among recently delivered women (3) and older women (3) to explore community perceptions about birth spacing, as well as to compile a list of health care providers who offered family planning services
- A household survey with 1,612 systematically sampled, recently delivered women to gather data on household sociodemographic factors, contraceptive knowledge and practices, and access to and use of health services
- 31 semi-structured interviews with health care providers and 4 focus group discussions with community opinion leaders, including religious leaders, members of Union Councils (local-level administrative bodies), and village government leaders, to obtain their opinions on healthy timing and spacing of pregnancies

Interviewers transcribed and coded the interview and focus group discussions, and the

research team reviewed the transcripts and codes to identify themes and relevant findings. When religious leaders understood that family planning was being integrated to support women's and children's health, they stated that they had no objection to this activity.

Perceptions of Birth Spacing Among Community Members

All 40 of the mothers and mothers-in-law that participated in the free-listing exercises were able to list at least 4 risks to either the mother or child associated with closely spaced births. Similarly, 38 of the 40 participants were able to list at least 3 benefits associated with a healthy birth-spacing interval, including physical, emotional (less mental stress), and economic benefits.

Nearly 78% of recently delivered women said that they desired a birth-spacing interval of 3 years or longer. During in-depth interviews, some men stated an economic interest in spacing births, and some were also aware of the physical toll that closely spaced births would have on the health of the mother.

Respondents generally did not perceive birth spacing as a high priority relative to other family needs. Mothers-in-law considered birth spacing of secondary importance to the provision of grandchildren, which they saw as a necessary and critical obligation of their daughters-in-law. Mothers themselves also said that birth spacing was not a very serious issue for them. Having many children within short intervals is common and perceived as normal in their communities; as a result, the women had not questioned the practice previously. Many of the husbands interviewed considered birth spacing as more important to their wives than to them.

Contraceptive Use Among Recently Delivered Women

Despite recognition of the risks of closely spaced births and the benefits of longer intervals, nearly 75% of the recently delivered women (who were not sterilized) were not using any contraceptive method to prevent pregnancy.

Knowledge of LAM Among Providers

Among health care providers, family planning service delivery reportedly focused more on limiting family size than on advocating birth spacing. Knowledge of LAM, including its objectives and criteria, was limited. (Three criteria for LAM must be met to provide effective protection against pregnancy: the mother's menstrual periods have not returned; the baby is fully or nearly fully breastfed and is breastfed often, day and night; and the baby is less than 6 months old.[25])

Service Delivery Strategies

Based on the findings that most women recognized the risks of short birth intervals and benefits of longer intervals, and that most wanted birth-spacing intervals of 3 years or longer, we developed a strategy that:

- More clearly specifies the healthy behaviors that women and couples need to practice to achieve these goals
- Reinforces risks and benefits
- Provides integrated family planning and MNH services, drawing upon existing cadres of community health workers (CHWs). Each CHW serves a population of about 4,000, or 4 villages.

The CHWs are young women from the local community with grade 10 education. All CHWs in both intervention and comparison areas received 21 days of basic MNH training, including skills development for behavior change communication, clinical assessment of neonates, and hands-on clinical training under supervision in a tertiary care hospital and in households. CHWs in the intervention area received an additional 3 days of training about healthy timing and spacing of pregnancy and postpartum family planning, including LAM, and 4.5 days of training about contraceptive methods and logistics management, according to protocols from the government of Bangladesh.

Community members could identify benefits of longer birth intervals, but birth spacing generally was not a high priority for them.

Timing of CHW Visits

In the existing Projahnmo MNH program, CHWs visited pregnant and postpartum women 6 times during the antenatal and postpartum period. They also made 1 visit every 2 months within their catchment area to identify pregnant women.

In the intervention area, the HFS integrated postpartum family planning counseling within 3 of the 6 existing MNH visits: at 30–32 weeks of pregnancy, 6 days postpartum, and once between days 29–35 days postpartum. The study also added 2 more visits, at 2–3 months and 4–5 months postpartum (Table 1), to educate

TABLE 1. Postpartum Family Planning Communication Messages, by Timing of CHW Visits

	CHW Visits Within Existing MNH Visits			New CHW Visits	
Communication Messages	**During Pregnancy**	**On Day 6 Postpartum**	**Between Days 29–35 Postpartum**	**Between Months 2–3 Postpartum**	**Between Months 4–5 Postpartum**
Benefits of longer birth intervals, risks of shorter birth intervals	✓	✓	✓	✓	✓
Essential newborn care, including exclusive breastfeeding	✓	✓	✓		
LAM, promotion of 6 months of exclusive breastfeeding	✓	✓	✓	✓	✓
Timing of return to fertility, signs indicating return to fertility			✓	✓	✓
Transition from LAM to another modern contraceptive method			✓	✓	✓
Discussion of contraceptive methods, potential side effects, strategies to minimize side effects			✓	✓	✓
Referral to health facility for contraceptive methods, if needed			✓	✓	✓

Abbreviations: CHW, community health worker; LAM, Lactational Amenorrhea Method; MNH, maternal and neonatal health.

LAM is often referred to as a ''gateway'' method of family planning, because many LAM users eventually accept another modern method.

families about postpartum family planning and provide services as needed.

Family Planning Interventions to Support Improved Newborn and Child Survival

We designed 3 family planning interventions specifically to support improvements in newborn and child health. The purpose was to ensure that adding family planning activities to the existing MNH services did not undermine program achievements to date in newborn health outcomes.

1. **Use of LAM during the first 6 months postpartum to prevent high-risk pregnancies.** LAM can be considered a maternal and child survival intervention because its use prevents high-risk pregnancy during the critical 6-month period after a birth. A recent meta-analysis showed that infants conceived during the first 6 months after a live birth are at elevated risk of multiple adverse outcomes.[14] Studies in multiple settings have shown LAM to be 98% effective, including with limited client contact.[26–28] In addition, a multicenter study found that two-thirds of LAM users eventually accept another modern contraceptive method.[28] In this largely rural region of Sylhet, where women's access to health facilities and to modern contraception is highly constrained, the HFS team decided to promote LAM use as a ''gateway'' method of family planning to address unmet need and to prevent high-risk pregnancies during the critical 6-month period after a birth. In the HFS intervention areas, CHWs always referred to LAM as ''LAM and Transition,'' emphasizing the importance of transitioning at 6 months postpartum to another modern method.
2. **Use of LAM to increase the duration of exclusive breastfeeding and improve breastfeeding practices.** LAM use is associated with improved exclusive breastfeeding practices. At the time of the HFS design, the median duration of exclusive breastfeeding in Sylhet division was less than 1 month (0.7).[29] Although LAM requires women to be *fully or nearly fully* breastfeeding, the HFS team decided to communicate the breastfeeding criterion of LAM as *exclusive* breastfeeding, to prevent the possibility of undermining exclusive breastfeeding practices promoted by the ongoing MNH program. The team hoped to

replicate results achieved in Jordan, where one study found that use of LAM promoted good exclusive breastfeeding practices.[30] The team also hoped that promoting use of LAM would increase the duration of exclusive breastfeeding.

3. **Use of other modern methods to achieve a 24-month birth-to-pregnancy interval, which is associated with reduced risk of under-5 mortality and improved maternal and child nutrition status.** Nearly half of all contraceptive users in Bangladesh stop using their method within 12 months of starting.[29] A global study found that high discontinuation rates were linked with low motivation to avoid pregnancy.[31] The HFS team explored whether conveying information to clients about the health risks to their infants posed by rapid, repeat pregnancies would be sufficient to motivate women to continue with a method for at least 24 months, or longer, after a live birth. We based communication messages on recommendations from a 2005 World Health Organization (WHO) Technical Consultation on Birth Spacing. The communication messages clearly specified the healthy behavior—that is, after a live birth, to use a modern contraceptive method for at least 24 months before attempting a pregnancy.[32] Risk information was conveyed in simple and easy-to-understand language; for example, ''if the pregnancies are too close together, the baby could be born too soon or be too small.''[32] We tailored messages to our target audiences of women, men, and communities, and we were as specific as possible to improve the potential for positive behavior change (Box).[33]

Development of Communication Materials

After conducting a desk review of existing information, education, and communication (IEC) materials in Bangladesh from NGOs and the government, we adapted materials on postpartum care from the Bangladesh Rural Health Service Delivery Program and developed, field tested, and refined into the local language 3 new leaflets on exclusive breastfeeding and birth spacing, LAM, and return to fertility after delivery (see supplementary material):

- **Postpartum care:** A pictorial description of postpartum services and potential postpartum complications, and the importance of visiting a health center at the sign of any complication. The leaflet also emphasizes visiting a health center for a postpartum physical check-up, for immunization of the baby, and to choose a contraceptive method.
- **Exclusive breastfeeding and birth spacing:** Describes exclusive breastfeeding, the benefits of birth-to-pregnancy spacing of at least 24 months, the citation from the Quran about breastfeeding, and visiting a health facility for consultations.
- **LAM**: A pictorial listing of LAM criteria and when to transition, and the importance of timely transition, to another modern method when LAM is no longer effective.
- **Return to fertility:** Describes the story of a woman named Asma; the story discusses the short time period before fertility returns after delivery, and variations in return to fertility from woman to woman, including messages describing the risk of becoming pregnant prior to the return of menses and as soon as 1 month postpartum if the baby is not breastfed, as well as the benefits of birth-to-pregnancy spacing of at least 24 months. The story was received well by women in the study, many of whom could relate to it.

Community-Based Distribution of Methods Added to Study Design

In the original study design, CHWs provided family planning counseling based on women's fertility intentions—whether and when women would like to have another child, or whether they would prefer to end childbearing—but they did not distribute contraceptive methods. There was demand among women for contraceptives but they had difficulty accessing them from health facilities.

After receiving approval from the JHU Institutional Review Board in July 2009 to amend the study protocol, the HFS team began training CHWs to distribute combined hormonal contraceptive pills and condoms, in accordance with Bangladeshi government protocols for in-home provision of contraceptives by community-based workers. That is, CHWs provided pills only after they completed verbal screening for medical eligibility to rule out risk factors that would preclude the woman from using the method. (The progestin-only pill is the preferred oral

Community-based distribution of contraceptives was added to the study design to meet women's demand.

BOX. Communication Messages Specific to Birth Spacing

Recommendations on Healthy Timing and Spacing of Pregnancy

- **24 months between pregnancies**
  After a live birth, wait at least 24 months before attempting the next pregnancy to reduce the risk of adverse maternal, perinatal, and infant outcomes.
- **6 months following miscarriage/induced abortion**

  After a miscarriage or induced abortion, wait at least 6 months before attempting the next pregnancy to reduce risks of adverse maternal and perinatal outcomes.

Health Outcomes Related to Short Birth Intervals

- **Less than 24 months from the last live birth to the next pregnancy**
  - Newborns can be born too soon, too small, or with a low birth weight.
  - Infants and children may not grow well and are more likely to die before the age of 5.
- **Less than 6 months from the last live birth to the next pregnancy**
  - Mothers may die in childbirth.
  - Newborns can be born too soon, too small, or with a low birth weight.
  - Infants and children may not grow well and are more likely to die before the age of 5.
- **Less than 6 months after a miscarriage or abortion to the next pregnancy**
  - Mothers are at higher risk of developing anemia or premature rupture of membranes.
  - Newborns can be born too soon, too small, or with a low birth weight.

Benefits of Healthy Timing and Spacing of Pregnancies

- **For newborns, infants, and children under 5**
  - Reduced risk of preterm births, low birth weight, small for gestational age, and, in some populations, stunting or underweight conditions.
  - Reduced risk of death for newborns, infants, and children under 5.
  - Increased chance that children will experience the health benefits of breastfeeding for a full 2 years.
- **For mothers**
  - More time to prepare physically, emotionally, and financially for the next pregnancy (if desired).
  - For young mothers, reduced risk of pregnancy-induced high blood pressure and associated complications, obstructed or prolonged labor, iron deficiency anemia, and maternal death.
  - More time to focus on infant, partner, and other children.
  - Reduced risk of pregnancy complications, such as preeclampsia.
  - May increase duration of breastfeeding, which is linked with reduced risk of breast and ovarian cancer.
- **For men**
  - Helps men safeguard the health and well-being of their partners and children.
  - Allows men time to plan financially and emotionally for their next child (if desired).
  - Contributes to a man's sense of satisfaction from supporting his partner in making healthy decisions regarding raising a healthy family.
- **For communities**
  - Reduces deaths and illnesses among mothers, newborns, infants, and children.
  - Helps to reduce poverty and improve the quality of life among community residents.

contraceptive during early breastfeeding; however, it was unavailable in Bangladesh until approximately January 2011 when it was introduced through private-sector health services.) CHWs distributed pills and condoms during their routine pregnancy surveillance visits every 2 months.

Beginning in March 2011, CHWs also started providing progestin-only injectable contraceptives to women enrolled in the HFS. Women must receive the injection every 3 months, but they have a window period and can receive the injection up to 2 weeks early or up to 4 weeks late (according to government of Bangladesh protocol and international guidance[34–35]). CHWs maintained a list of all injectables users in their planning book, in which they noted the injection receipt date and the next scheduled date. During their regular pregnancy surveillance visits in the community or during community visits for antenatal or postpartum monitoring, CHWs provided injections to injectables users if the dates matched. CHWs also made *active* referrals for clinical contraceptive methods—that is, CHWs accompanied women desiring clinical methods to the facility.

Community Mobilization and Education

In addition to the one-on-one counseling provided by CHWs, male and female community mobilizers organized monthly meetings at the cluster level with pregnant and postpartum women, their husbands, mothers-in-law, and fathers-in-law to discuss the importance of birth-spacing practices and postpartum family planning, including LAM and return to fertility after delivery. At the meetings, the mobilizers recognized women who practiced LAM successfully, some of whom were designated as ''LAM Ambassadors.'' LAM Ambassadors provided information and support to pregnant and postpartum women in their communities about the value of LAM. Their healthy and well-spaced babies appeared to be an effective advertisement for the healthy family planning behaviors advocated by HFS.

Community mobilizers also conducted advocacy meetings with local leaders, including religious leaders, teachers, businessmen, government, and NGO staff, to sensitize the community about study activities.

METHODS

Study Design

In December 2007, enrollment of pregnant women began in 4 unions that had ongoing maternal and neonatal health programs. (A union is the lowest administrative unit with, on average, a population of 25,000 people and a primary health care facility.) We intended to enroll women over a 7-month period (through June 30, 2008), but we received additional funding that allowed us to increase the study area to 8 unions, thus expanding the enrollment period through July 14, 2009 (Figure).

The Healthy Fertility Study used successful LAM users, designated as ''LAM Ambassadors,'' to promote LAM to other pregnant and postpartum women in their communities.

Using a quasi-experimental design, and relying primarily on pre/post-household surveys among study participants, we purposefully selected 4 unions to receive the intervention and 4 other unions to serve as the comparison group, receiving standard maternal and newborn care promotion only.

The study unions were purposively selected to:

1. Minimize contamination between intervention and comparison groups and with other ongoing nongovernmental organization (NGO) programs
2. Exclude unions having an *Upazila* (subdistrict) Health Complex (hospital facility with inpatient and outpatient services), as this would represent a large difference in availability of health services
3. Include unions with functional government facilities and workers designated for providing family planning services

During the Healthy Fertility Study, community mobilizers met with religious leaders during advocacy meetings.

The study was approved by the Johns Hopkins University (JHU) Institutional Review Board and the Bangladesh national ethics committee of Bangladesh Medical Research Council and is registered as a Clinical Trial (Identifier: NCT01702402).

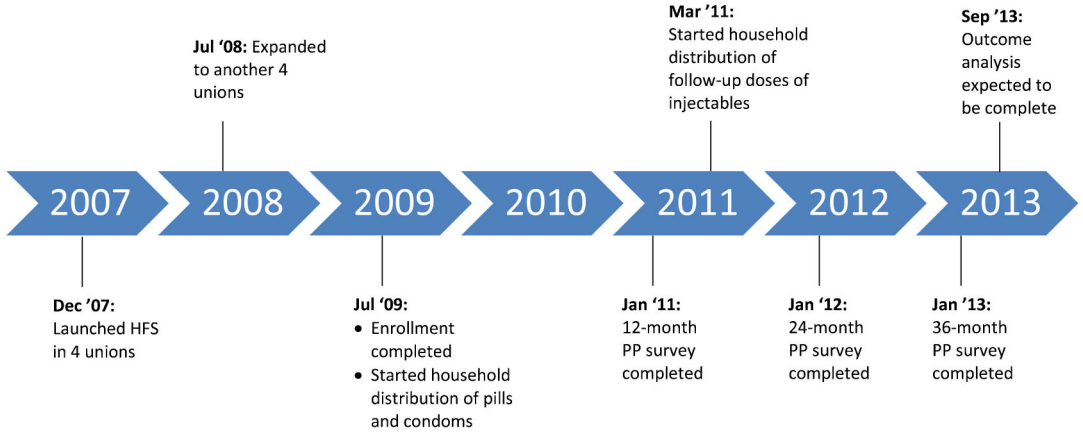
Sample Size and Outcomes of Interest

Following recommendations from the 2005 WHO Technical Consultation on Birth Spacing,[32] this intervention promotes knowledge and use of contraceptive methods to increase birth-to-pregnancy intervals to at least 24 months (equivalent to a birth-to-birth interval of 33 months, or almost 3 years) to improve newborn, infant, child, and maternal health outcomes.

Although birth-to-birth intervals can be measured more accurately than birth-to-pregnancy intervals, from a programmatic perspective, it is easier to communicate messages about birth-to-pregnancy intervals, because women and their partners think in terms of the time from the birth of one child to the conception of the next child. Thus, the household survey questionnaires refer to birth spacing in terms of birth-to-pregnancy intervals. However, birth-to-birth interval is the study's primary outcome measure.

To calculate sample size, we hypothesized that the proportion of women having another birth within 33 months of the last birth will be 12% in the intervention area and 16% in the comparison area—a 25% difference. To measure a 25% decrease in the proportion of women with a birth interval shorter than 33 months with 80% power and 5% significance level required a sample size of 1,181 pregnant or postpartum

FIGURE. Timeline: Implementation of Healthy Fertility Study



Abbreviations: HFS, Healthy Fertility Study; PP, postpartum.

women per study arm. Taking into account a design effect of 1.5, we estimated we would need to increase the sample size to 1,772 women per study arm. We assumed a 20% loss to follow-up (10% per year), which further increased the sample size to 2,215 per arm (4,430 total). This sample size is sufficient to measure hypothesized changes in contraceptive knowledge and use and birth-to-birth intervals of 33 months. The total number of women enrolled was 4,570, slightly higher than anticipated as a result of ongoing field operations in several locations simultaneously (n=2,280 in intervention group, n=2,290 in control group). The final study cohort was comprised of 4,504 women (2,247 in intervention and 2,257 in control group) for whom data on pregnancy outcomes were available.

Data Collection

A team of data collectors not involved in implementing the intervention conducted 8 data collection visits for each study participant:

- 1 visit during the antenatal period completed before weeks 30–32 of pregnancy (considered the baseline)
- 7 follow-up visits during the postpartum period (at 3, 6, 12, 18, 24, 30, and 36 months postpartum)

In addition to the independent data collectors, CHWs also collected data used to evaluate the intervention, including date of birth of newborns, birth weight, and neonatal outcomes. A separate team of data collectors conducted verbal autopsies of all reported infant deaths occurring in both study arms.

PRELIMINARY RESULTS

Baseline Findings on Enrolled Participants

Women in the intervention and comparison groups were similar in terms of age, husband's education, religion, and parity (Table 2). Women's education was slightly higher in the intervention group than in the comparison group. Levels of ever-use of contraception were slightly lower in the intervention group (18%) than in the comparison group (21%), and fertility desires were slightly higher (wants more children) (60% versus 56%, respectively). Women in the intervention group were comparatively poorer than women in the comparison group, but the difference was not statistically different (P=.10).

CHW Visits

There was no difference in coverage of women by CHWs in the intervention versus control groups (Table 3). During pregnancy, CHWs visited more than 99% of women in both study groups. During the first 3 months postpartum, CHWs visited about 96% of women in the intervention group and 93% of women in the control group. However, within the first week of delivery, CHWs visited comparatively fewer women in the intervention group than in the control group (89.8% versus 96.4%, respectively; P<.05). Still, the mean number of CHW visits was higher in the intervention than in the control group (4.2 versus 3.5, respectively; P<.01). This was not unexpected since CHWs provided contraceptive methods to women in the intervention group, which probably required additional CHW visits for resupply of methods.

DISCUSSION

This article describes the design of an operations research study that integrates postpartum family planning education and services within an existing community-based maternal and newborn care program in a low-resource setting.

The HFS adds to the literature on postpartum family planning. In developed countries, promotion of postpartum family planning is a standard component of obstetric care.[36] Postpartum family planning is also included in guidelines for health care workers in developing countries, but in practice, such services may be provided infrequently.[37] A 2010 Cochrane review identified 4 short-term, randomized controlled trials of postpartum family planning counseling interventions, 2 of which had insufficient sample size and/or data. The remaining 2 studies found that counseling leads to increased use of contraceptive methods.[36] The trials took place in developed countries (Australia and the United States), all of the interventions were provided primarily by trained health professionals, and most counseling sessions were provided in a clinical setting, frequently in the hospital after delivery. In a non-randomized controlled trial in Chile, an integrated model of family planning promotion and infant care showed gains in infant care indicators and high rates of contraceptive acceptance in the intervention group, but the

TABLE 2. Baseline Characteristics of Enrolled Study Participants (N=4,570)

Characteristic	Study Group		
	Intervention (n=2,280)	Comparison (n=2,290)	*P* value
Age, mean (95% CI), y	26.5 (25.4–27.6)	26.6 (26.0–27.3)	.86
Years of schooling, mean (95% CI)			
Women	4.5 (4.1–4.8)	4.1 (3.6–4.5)	.11
Husbands	4.0 (3.4–4.6)	4.0 (3.2–4.7)	.88
Religion			
Muslim	94.5%	91.4%	.40
Hindu/other	5.5%	8.6%	
Parity, mean (95% CI)	2.2 (2.0–2.3)	2.2 (1.9–2.3)	.74
Economic Status, %			
Poorest	18.6	22.6	.10
Poor	16.8	22.8	
Middle	19.5	20.2	
Rich	22.6	17.2	
Richest	22.5	17.3	
Ever used contraception, %	18.0	21.1	.51
Fertility desires, %			
Wants more children	59.7	55.7	.36
Wants no more	26.0	32.4	
Undecided/up to God	14.3	11.9	

Abbreviations: CI, confidence interval.
P values are adjusted for clustering effects. *P* values ≤ .05 were considered statistically significant.

study was not designed to measure differences in contraceptive continuation between the intervention and comparison groups.[38]

Results of the study described in this article are currently being analyzed and will be published in a future paper.

Number and Timing of CHW Visits

The HFS intends to fill a gap in the literature on postpartum family planning by providing guidance about a scaled-up package of integrated community-based care, including about the appropriate number and timing of CHW household visits. Our postpartum family planning intervention package included 1 antenatal visit and 4 postpartum visits during the first 5 months postpartum, plus 1 visit every 2 months for pregnancy surveillance and contraceptive distribution.

One antenatal and 3 postpartum visits are feasible and sustainable in many community-based MNH programs, including in Bangladesh. For example, the Maternal and Child Health Integrated Program (MCHIP) in Bangladesh

TABLE 3. Coverage Rates of Community Health Worker (CHW) Visits

	Study Group		
Timing of CHW Visit	**Intervention (n=2,183)**	**Comparison (n=2,216)**	***P* value**
During pregnancy	99.4%	99.6%	.42
Within 3 months postpartum	95.6%	93.0%	.21
Within first week postpartum	89.8%	96.4%	.007
Mean number of visits	4.2	3.5	.001

P values ≤ .05 were considered statistically significant.
During pregnancy, denominator is all women with complete information.
During the postpartum period, denominator is all women with a surviving infant at 3 months postpartum.

funded by the U.S. Agency for International Development (known as the MaMoni project) is implementing an MNH program in 2 districts that involves 3 postpartum visits with integrated family planning counseling and services. Although the 5 CHW visits in the HFS intervention package may be considered intensive, preliminary results indicate that the large majority of women received the full number of scheduled visits and that the schedule did not compromise worker performance. Based on programmatic experience, the HFS team concluded that fewer visits would lead to gaps in continuation of breastfeeding and the transition from LAM to other modern contraceptive methods.

Community-Based Distribution of Contraceptives

Doorstep delivery of contraceptives was not originally part of the HFS intervention package. The government of Bangladesh had moved away from community-based distribution of contraceptives toward clinic-based provision of family planning services.[39–41] However, HFS-enrolled women began requesting contraceptives from CHWs, and so we added contraceptive distribution to the study design as an opportunity to potentially enhance intervention impact. In this culturally conservative area, women's movement outside the home is curtailed, even more so than in other areas of Bangladesh, which limits their contraceptive access.

Building on Lessons Learned From Other Community-Based Integrated Programs

The HFS builds on important lessons from the Bangladesh Matlab Family Planning–Health Services Project[42] and the Navrongo research in Ghana[43]—both of which provided integrated family planning and maternal and child health services—but focuses on previously neglected areas and new emerging public health issues.

Type of Health Care Provider

The HFS relies on service delivery through locally recruited CHWs with a grade 10 education. In contrast, the Navrongo project achieved results by using more highly educated health care professionals—nurses—a cadre not widely available in many developing countries.

Although making 5 CHW visits may be considered intensive, preliminary results indicate it was feasible.

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Community health workers provided doorstep delivery of oral contraceptive pills and other modern methods to women in their communities.

Targeting of Services to Pregnant and Postpartum Women

The HFS targets family planning services to pregnant and postpartum women—an underserved group of women with demonstrated high unmet need for family planning—not to all women in the community, as with the Matlab[42] and Navrongo projects. It also reaches first-time mothers, who are at higher risk than women with 2 or 3 births. In 2005, a literature review identified 27 integrated programs at the community level, and only 5 focused on the postpartum period.[44] Focusing efforts on postpartum women also might improve consistent CHW household visits; Matlab field workers were supposed to visit all eligible women every 3 months, but they averaged only 1.5 visits per year per woman.[39]

Improving Family Planning Continuation Rates

The Matlab project demonstrated progress in improving contraceptive continuation rates,[5] but first-year discontinuation rates are still high in Bangladesh. At the time of the HFS design, 1-year contraceptive discontinuation rates had increased from 49% in 2004 to 57% in 2007.[3] The HFS evaluation is examining the extent to which the intervention motivates women to continue using family planning for at least 2 years without interruption.

Lengthening Birth-to-Pregnancy Intervals

Matlab made progress in helping women to space their pregnancies, yet currently in Sylhet, 47% of second-order and higher births are spaced less than 36 months apart, and for the 15–19 age group nationally, this percentage rises to 80%.[6] HFS communication messages focus specifically on preventing high-risk pregnancies by increasing birth-to-pregnancy intervals, in part through use of LAM—a method for which efficacy studies were carried out only relatively recently, between 1997 and 2000. Thus, LAM was unavailable when Matlab and Navrongo were carrried out.

Newborn Mortality

Navrongo demonstrated reductions in child mortality,[43] but by the 1990s under-5 mortality in most developing countries was increasingly dominated by newborn mortality, which called for a different set of interventions. HFS includes interventions to reduce newborn and infant mortality by focusing on the 1-year extended postpartum period.

Sequencing of Integration Activities

The HFS design adds postpartum family planning education and services into an ongoing and successful maternal and newborn care program, whereas with the Matlab project, maternal and child health services were gradually added to the responsibilities of the family planning field worker.

The findings from the HFS trial are anticipated to help practitioners provide women and infants in low-resource settings with an integrated, community-based continuum of care.

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FIELD ACTION REPORT

Successful use of tablet personal computers and wireless technologies for the 2011 Nepal Demographic and Health Survey

Deepak Paudel,[a] Marie Ahmed,[b] Anjushree Pradhan,[c] Rajendra Lal Dangol[d]

Using tablet personal computers and wireless technologies in place of paper-based questionnaires to administer the Nepal DHS in a geographically diverse setting appeared to improve data quality and reduce data collection time. Challenges include inconsistent electricity supply, safe storage and transport of equipment, and screen readability issues under direct sunlight, which limited confidential interview spaces.

ABSTRACT

Computer-Assisted Personal Interviewing (CAPI), coupled with the use of mobile and wireless technology, is growing as a data collection methodology. Nepal, a geographically diverse and resource-scarce country, implemented the 2011 Nepal Demographic and Health Survey, a nationwide survey of major health indicators, using tablet personal computers (tablet PCs) and wireless technology for the first time in the country. This paper synthesizes responses on the benefits and challenges of using new technology in such a challenging environment from the 89 interviewers who administered the survey. Overall, feedback from the interviewers indicate that the use of tablet PCs and wireless technology to administer the survey demonstrated potential to improve data quality and reduce data collection time—benefits that outweigh manageable challenges, such as storage and transport of the tablet PCs during fieldwork, limited options for confidential interview space due to screen readability issues under direct sunlight, and inconsistent electricity supply at times. The introduction of this technology holds great promise for improving data availability and quality, even in a context with limited infrastructure and extremely difficult terrain.

BACKGROUND

The advent of mobile and wireless technology has created countless opportunities to connect ideas and information that would never have been tapped with traditional technology, such as desktop computers or non-electronic mechanisms. As mobile and wireless technology has become more affordable, reliable, powerful, and user-friendly,[1] its adoption has exploded, particularly in less-developed countries where access to infrastructure for information and communication technologies, such as landlines, is limited. Use of appropriate technology can play an important—and even transformative—role in providing more accurate and rapid information.[2–3] This paper highlights lessons learned, benefits, and challenges of using Computer-Assisted Personal Interviewing (CAPI) and wireless technology to collect data for a large-scale survey in Nepal—a geographically difficult and resource-poor environment.

Ranked 157th of 187 countries in the Human Development Index,[4] Nepal features a small territory (147,181 sq km) with diverse geography and a relatively small population (26.6 million)[5] but with ethnic, religious, and cultural diversity that adds another layer of development challenges.

The country has also been wracked by a decade-long conflict that nominally ended in 2006, but the country remains fragile politically. Communications and transportation systems are improving but are still poor. Only 43% of the population has access to all-weather roads.[6] The majority of the population (67%) has access to some electricity, but it may not be available 24 hours per day year-round.[5] Nepal currently has about 10 million telecommunications users,

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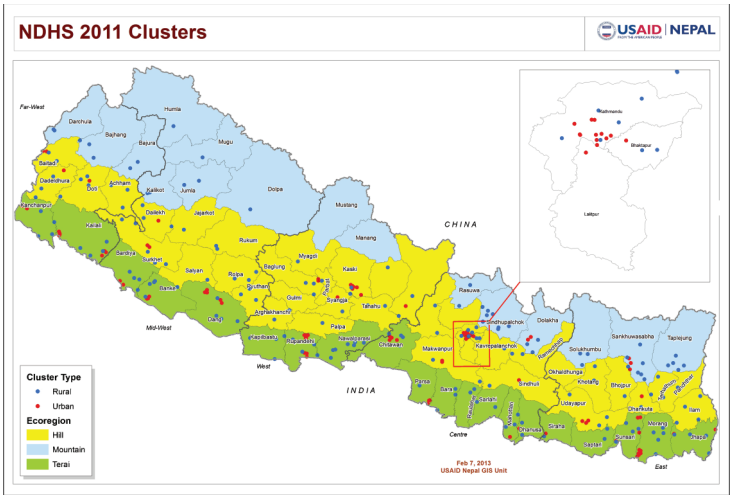


The 2011 Nepal Demographic and Health Survey (NDHS) is a nationally representative survey covering both rural and urban areas.

Using microcomputers for data collection reduces error rates and collection time.

89% of whom use mobile phones.[7] In contrast, in 2000, there were only 300,000 telecommunications users, with less than 4% using mobile phones.[8]

The Demographic and Health Survey (DHS) is a nationally representative survey that provides reliable data on population and family planning, health, HIV, and nutrition in more than 90 countries, using mostly paper questionnaires.[9]

Nepal conducted the DHS in 1996, 2001, and 2006 using paper questionnaires. Nationwide data collection with paper-based questionnaires usually takes 5 to 6 months, and data entry, which overlaps with the fieldwork, is completed a month after completing the fieldwork. The final report is available approximately one year after concluding the fieldwork.

In 2011, ICF International (an international organization that provides technical assistance to carry out the DHS) and New ERA (a local research firm in Nepal that specializes in large-scale surveys), in collaboration with the Ministry of Health and Population, conducted the DHS in Nepal using tablet personal computers (tablet PCs); the preliminary report was published within 2 months, and the final report within 9 months, after data collection. The objective of transitioning from paper questionnaires to tablet PCs was to ensure higher-quality data collection and timely reporting.

Use of microcomputers closer to the point of data collection has proved to significantly reduce error rates and produce data quickly.[1] Nepal is the second country in the world to use tablet PCs to collect DHS data and the first country to develop and use a non-Latin script for the DHS using tablet PCs.

THE TOOL AND TECHNOLOGY

The Nepal DHS (NDHS) team initially considered using a number of different tools for the 2011 data collection effort, including personal digital assistants (PDAs), iPhones, iPads, tablet PCs, Android tablets, and standard laptops. We eliminated PDAs and iPhones, with their small screen sizes, as options because of the length and complexity of the DHS questionnaire. We also eliminated Android tablets and iPads because they were incompatible with the Windows-based DHS software, CSPro (Census and Survey Processing System). Compared with tablet PCs, standard laptops are heavier, susceptible to humidity and dust, and have a relatively short battery life, so the tablet PC emerged as the best option. We selected the ASUS Tablet PC T101MT based on cost, local availability, battery life, and user-friendliness. Specifications of ASUS PC T101MT include: Intel ATOM N450 CPU processor, 10.1-inch touchscreen display (1024 x 600) with PenWrite technology; 1.3 kg weight, dimensions of 26.4 × 18.1 × 3.1 cm, and average battery life of 6.5 hours.

A tablet PC is a portable personal computer equipped with a touch screen as a primary input device. Generally, tablet PCs have an integrated wireless adapter for connecting to the Internet and local networks and Bluetooth for transferring data over short distances.

Generally, the interviewer used a stylus to enter the response and the optional keyboard when the stylus was not working properly. However, supervisors used the keyboard the majority of the time while reviewing the data.

Nepal's mobile network uses both Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA) technology. We chose to use the CDMA2000 1X network, provided by Nepal Telecom, based on its wider coverage, especially in rural areas (2,765 of 3,915 village development committees have CDMA coverage). Using the CDMA network, field workers transferred data from the field to the main office via the Internet using a protocol developed by ICF International called Internet File Streaming System (IFSS). We also used IFSS to

deploy software updates from the central server to supervisors and interviewers in the field.

THE TEAM

The survey organization team trained and mobilized 65 interviewers, 16 supervisors, and 8 data quality assurance supervisors, divided into 16 teams. Selection of interviewers and supervisors consisted of initial screening, a written examination, practical exercises on using computers, and personal interviews.

Candidates had to be computer literate, which we defined as having the ability to operate basic computer functions without any specific guidance and having some experience using computers for other purposes. We invited 89 candidates (10 more than what was needed to account for potential dropouts) to participate in the training program. As a result of the computer literacy requirement, the demographic profile of the selected fieldworkers was different than that of the fieldworkers from previous NDHSs using paper questionnaires. Approximately 35% of the field staff for the 2011 DHS was under 25 years of age, and over half were under the age of 30. Interviewers possessed at least a bachelor's degree in fields such as population studies, sociology, and public health. Only 15% of the 89 interviewers and supervisors for the 2011 NDHS had participated in data collection for a previous NDHS.

After extensive training, including intensive coaching for some interviewers on how to use tablet PCs and how to navigate different window screens, we deployed the field workers in 16 teams in Kathmandu Valley, where the research team could monitor and mentor all the field workers closely during the early stage.

THE PROCESS

Using CAPI, the interviewer enters the respondents' responses directly into a computer database. CAPI provides several advantages, such as:

- ability for the interviewer to select the appropriate language in which to administer the questionnaire
- automatic skip-pattern and validation of the response, minimizing data-entry errors
- drop-down menus to select appropriate options

The interviewers entered data directly into the tablet PC during each interview and submitted the data to their respective supervisor at the end of each day using the Bluetooth file transfer system. The supervisors reviewed the data for inconsistencies and provided immediate feedback to the interviewers, for example, to check whether the correct identity and line number were entered so that data could be linked properly or to identify other inconsistencies that could not be captured with the computer program, such as matching the respondent's name and sex.

Once data quality was assured, the supervisor transferred the data to the central office using IFSS through the CDMA network. The database manager in Kathmandu then checked the data reported by the field teams and provided feedback as soon as possible via mobile phones if inconsistencies were detected (see Figure).

Data collection for the NDHS started in February 2011. After completing 1 month of data collection, we organized review sessions to discuss progress, challenges, benefits, and areas for improvement related to data collection and use of the tablet PCs, Bluetooth, and IFSS system. Since all interviewers were trained on how to use the paper surveys as a backup to the tablet PC, they were able to compare the two experiences even if they had not participated in the previous paper-based DHS.

We also asked interviewers about respondents' perceptions of the tablets, logistical challenges, connectivity and data transfer challenges, and other technical issues. During the review sessions, we provided any necessary technical support and guidance to the field teams on the use of tablet PCs and wireless technology, the interviewing process, and other logistical issues.

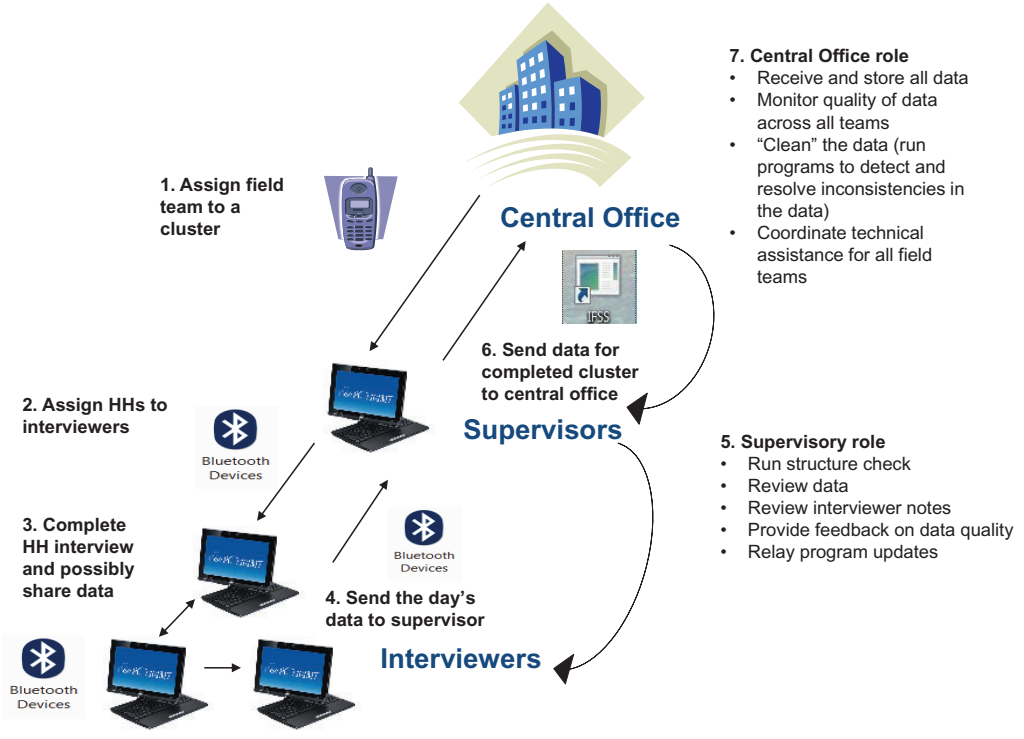
BENEFITS TO USING CAPI

We identified several benefits—some unanticipated—to using tablet PCs during our discussions with the field workers.

Improved Data Quality

The most important benefit to using tablet PCs for data collection, as perceived by 80% of the interviewers, was that the survey software guided the interview, improving the interview experience, primarily because it was easier to administer the questionnaire and ensure data

FIGURE. Data Collection and Reporting Scenario



Abbreviations: HH, household; IFSS, Internet File Streaming System.

In the 2011 Nepal DHS, interviewers collected household data on their tablet PCs and submitted it to their supervisors using Bluetooth technology. Supervisors provided immediate feedback to the interviewers, when necessary, and transferred the data to the central office using a protocol called Internet File Streaming System. Illustration prepared by ICF International.

Built-in skip patterns and automatic error messages in the electronic questionnaire improved data quality.

quality. For example, the built-in skip patterns in the electronic questionnaire reduced the chance of missing questions or following incorrect skip patterns. Also, the automatic error messages alerted interviewers to any inconsistencies in the information provided by the respondents, such as birth of a child before the date of first sex. The interviewers could resolve these inconsistencies immediately, reducing the chances of collecting inconsistent data.

Reduced Data Collection Time

The majority of interviewers (70%) indicated anecdotally that the electronic format saved time in conducting the interview because of the built-in skip patterns, filters, and auto-fill features (with calendars, for example). Implementing CAPI reduced the overall time needed for data collection by approximately one month (6.5 months for data collection in 2006 compared with 5.5 months in 2011). Elimination of data-entry redundancy with paper questionnaires contributed to the time savings. In addition, new data could be aggregated and checked for consistency on a daily basis.

Ease of Handling

Field interview teams quickly learned how to handle the tablet PCs without difficulty, with 68% of interviewers indicating that use of the tablets was straightforward and that they could move through the questionnaires easily. The remaining interviewers were able to manage the tablets after some practice.

Overall, use of Bluetooth and IFSS was also smooth. The connection to the CDMA network took, on average, one minute and data transfer to the server in Kathmandu took approximately 5 to 7 minutes. In contrast, in the past, paper-based surveys had to be sent to Kathmandu via pouch mail or hand-carried, which took days or even weeks.

Interviewers also cited the convenience of carrying the tablet PCs instead of cumbersome paper questionnaires, an expected benefit particularly in the remote hilly and mountainous areas where interviewers may have to hike for several hours or days to reach respondents.

Tablet PCs can also be used in low-light situations, so interviewers were able to work during evening hours, which would have been a challenge with paper questionnaires due to frequent power outages.

Use of tablet PCs can also be helpful to switch languages during interviews, compared with paper questionnaires.

Improved Feedback Loop

Using tablet PCs for data collection and daily data transfer offered a stronger feedback loop between interviewers and the central backstop team than with paper questionnaires. The NDHS backstop team was able to provide relevant feedback to the interviewers faster, which improved data quality, resulting in less frequent missing and inconsistent values. Prompt feedback also motivated interviewers to track their own progress toward targets more effectively.

Positive Perception of Respondents

Interviewers reported that survey respondents were curious about being interviewed using the tablet PCs. The interviewers perceived a high level of respect and enthusiasm from respondents, and they felt that respondents viewed them as technical employees with higher education. This was an unanticipated, but encouraging, finding, especially because of respondents' limited exposure to computers.

Interviewers also reported that respondents perceived that the use of technology validated the DHS data collection process, and respondents were more willing to participate in the survey due to the perceived importance of the survey. Some respondents told interviewers that they felt the electronic process was more confidential than paper-based forms because the electronic versions could not be readily seen by others.

CHALLENGES WITH USING CAPI

Although the use of tablet PCs has been encouraging, the innovation has not been without its challenges.

Storage and Transport

A key challenge was the storage and transport of tablet PCs during fieldwork. The interviewers conducted their fieldwork in community clusters, where news of the tablet PCs can spread quickly, adding a dimension of security concerns and requiring interviewers to be vigilant because they were accountable as a team for any theft or damage. Safe storage was a particular challenge in remote areas because some interviewers had to stay in community members' homes.

Safe storage and transport of the tablet PCs during fieldwork was a key challenge.

To alleviate these challenges, the interviewers traveled in teams and so they could support each another in protecting the equipment. In addition, team members were trained to lock and be aware of their tablet PCs at all times, even during meal and rest times.

Interviewers also expressed concerns about protecting the equipment from rain, particularly of concern during the monsoon season. However, we concluded fieldwork by June 2011, just prior to the monsoon season.

Using tablet PCs and wireless technology facilitated prompt feedback between fieldworkers and the central backstop team.

Limited Confidential Interview Environment

Because tablet PC screens are difficult to read outdoors, particularly under direct sunlight, it limited the options for confidential interview space. Interviewers often had to conduct interviews inside the home, where it was a challenge to maintain privacy due to small living spaces and thin walls in rural Nepali homes. This was of particular concern when asking sensitive questions related to sexual behavior and domestic violence. The tablet PCs also sometimes attracted other people who were curious about the technology. The interviewers often had to make extra effort to maintain privacy, which usually demanded more time to administer the questionnaire.

Consistent Availability of Electricity

Nepal relies primarily on hydropower, and so electricity shortages increase significantly in most areas of the country during the dry season between February and April—the time period during which we collected data. Some areas were without electricity for more than 14 hours per

An interviewer uses his tablet PC to collect responses from a rural woman.

day. Recharging the tablet PCs in this environment was a major impediment.

We equipped interviewers with extra batteries that had approximately 6.5 hours of charge per battery, which temporarily addressed the issue of low battery power during interviews. But teams still had to find a power source to charge all the batteries and their mobile phones at the end of the day.

Backup plans in case of power outages must be put in place in resource-constrained environments.

Solar chargers were not practical because interviewers were busy using their tablet PCs during the sunlight period. Therefore, as a contingency plan, interviewers carried a few paper questionnaires and extra batteries to use as needed. We also provided portable generators to interviewer teams located in areas lacking electricity.

Other Challenges

Although acceptability of the tablet PCs was high among respondents, there were a few cases of skepticism. As part of the informed consent process, respondents were informed that the interview would not be video- or audio-recorded and that the recording feature had been disabled on the tablet PCs. However, a few respondents were still concerned.

We also had to make minor revisions in the data-entry software once the team was in the field, for example, to increase the maximum number of family members that the interviewer could enter into the database. We made these changes at the central office in Kathmandu and provided the updated files to the interviewers through IFSS.

LESSONS LEARNED

Key lessons learned from our experience in Nepal:

Selection and training of interviewers: Proper selection and thorough training of interviewers is crucial for the success of the program. The interviewers received 5 weeks of training, 1 week longer than previous DHS training for paper questionnaires. The training covered interviewing skills, types of questions in the DHS, administration of the paper questionnaire, and proper use and handling of tablet PCs, Bluetooth, and IFSS. Examples of issues that may affect the quality of the interview experience and data collection, but that can be resolved through training, include the pace of checking completed forms, awareness of battery life, and calibrating the touch screen to ensure the stylus marks the correct responses.

Equipment care: Training on proper handling and care of the equipment is also very important, particularly in a rural context where the equipment has to be transported through rough terrain, the power supply is not stable, and unexpected rain is a concern. We provided teams with generators, rain shields, umbrellas, and several other items to manage these challenges. Enforcing joint responsibility for theft of, or damage to, the tablet PCs among the interviewer teams helped to ensure security of the tablets during transport and storage. With proper care and maintenance, these tablet PCs (and portable generators) can be reused in future surveys, resulting in additional cost savings over the long term.

Maintaining data security: Data security is a prime issue; daily backup of the data should be done properly. After completing each interview, the data were automatically saved to an external data card on each tablet PC. We also provided team supervisors with flash drives for daily data backup, in addition to daily data transmission to the central database server.

Immediate feedback on data quality: Regular, often immediate, feedback helped to resolve technology and survey-related problems in a timely fashion, resulting in improved data quality. Review meetings that focused on both

individual and team issues provided additional opportunities for feedback and practical problem solving.

Adequate preparation: Sufficient time must be allocated to designing and pretesting the electronic questionnaire and to overall testing and debugging the software, particularly for questionnaires in multiple languages and in a non-Latin script, as was the case in Nepal. DHS questionnaires are lengthy and complex, so it is crucial to ensure that the question flow and skip patterns function correctly before using them in the field.

Local purchase: Purchasing the tablet PCs and accessories locally facilitated more efficient servicing of equipment than if we had purchased the equipment internationally. Although new technology, such as tablet PCs, may be more expensive in less-developed countries such as Nepal, the probable cost saved in shipping and delays can more than make up for that difference.

Interviewers transfer data between tablet PCs.

CONCLUSION

The use of tablet PCs and wireless technology to administer a complex survey in Nepal has demonstrated potential to improve data quality and reduce data collection time. These benefits outweigh manageable challenges, such as inconsistent electricity supply, storage and transport of the tablet PCs, and limited confidential interview environment. Use of technology holds great promise for improving data availability and quality, even in a context with limited infrastructure and difficult terrain. Because use and evolution of such technology is growing rapidly, it may be helpful to carry out further detailed research, including cost-benefit analysis, to precisely report the time, cost, and human resource savings and improved data quality through the use of technology.

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GLOBAL HEALTH: SCIENCE AND PRACTICE
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CORRECTION

Corrigendum: Jacobstein et al., Contraceptive implants: providing better choice to meet growing family planning demand

Roy Jacobstein,[a] Harriett Stanley[a]

In the article "Contraceptive implants: providing better choice to meet growing family planning demand" by Roy Jacobstein and Harriet Stanley, which appeared in the March 2013 issue (Volume 1, Issue 1), the second sentence in the box on page 14 incorrectly stated implants use rose 31-fold in Rwanda. This has been corrected to "more than 15-fold."

In addition, on page 11, in the first sentence of the first paragraph under "What Women Like About Implants," the term ultra-low "dose" was changed to ultra-low "amount," to avoid the incorrect implication that implants deliver hormones into a woman's body in a single dose. In the third sentence, the missing word "protection" was added after "contraceptive" (…offer up to 3 to 5 years of extremely reliable contraceptive protection…).

The article has been corrected accordingly.

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