Sustainability science: an integrated approach for health-programme planning

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Planning for programme sustainability is a key contributor to health and development, especially in low-income and middle-income countries. A consensus evidence-based operational framework would facilitate policy and research advances in understanding, measuring, and improving programme sustainability. We did a systematic review of both conceptual frameworks and empirical studies about health-programme sustainability. On the basis of the review, we propose that sustainable health programmes are regarded as complex systems that encompass programmes, health problems targeted by programmes, and programmes' drivers or key stakeholders, all of which interact dynamically within any given context. We show the usefulness of this approach with case studies drawn from the authors' experience.

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Introduction

Policy makers, donors, programme managers, and communities often face challenges in sustaining seemingly worthwhile health programmes, especially in low-income and middle-income countries. The Mexico Statement on Health Research called on national governments to pursue sustainable programmes to support public health and health-care delivery systems.[1] Most concerns about sustainability are related to premature discontinuation of programmes after an initial period of support. In addition to the needs left unmet, discontinued programmes are wasteful of human, monetary, and technical start-up investments, and can diminish community trust and support for future programmes.[2]

Ministers of health and other key stakeholders wanting to optimise health-programme sustainability would benefit from a practical framework derived from empirical research to support their approach to programme planning. Many studies of health programmes in low-income and middle-income countries have sought to identify factors associated with sustainability, but these data have not been systematically reviewed. Furthermore, several divergent conceptual approaches exist but their basis in empirical research has not always been articulated.

We aimed to review existing perspectives and empirical research about health-programme sustainability; to draw on the review to derive a practical framework for understanding health-programme sustainability; and to use this framework to propose an approach to planning for health-programme sustainability and developing a strong evidence base to support refinements to and implementation of the approach.

Procedures

We did a systematic review of both conceptual frameworks and empirical studies about health-programme sustainability. We searched Medline (1980 to June 18, 2008), EmBase (1950 to June 18, 2008), and the Cochrane library.

For the search strategy framework, we used words and MeSH and EMTREE headings that encompass programme sustainability, including synonyms such as "continuation", "institutionalisation", "resilience", "durability", "viability", "stability", "persistence", and "maintenance". We then restricted the search to citations included under health-care organisation and community-care MeSH headers, and not included under the agriculture MeSH headers. After retrieving articles, we manually searched the bibliographies of all relevant references to identify further publications. We searched PubMed with the names of key authors to identify additional references, and we searched for related articles to all relevant references.

Two researchers independently screened title and abstracts of all citations identified from each search, and selected potentially relevant reviews, conceptual papers, and primary studies. Both researchers independently retrieved full-text articles, and examined them to exclude those that did not focus mainly on sustainability and health programmes.

We identified and described the main perspectives on sustainability in the included articles. We described articles that assessed a health programme over a defined period, and extracted factors that the investigators thought to be associated with sustainability of the programme, irrespective of whether or not a measure of sustainability was reported. We discussed any

Key messages

- A comprehensive approach to health-programme sustainability based on the available evidence would benefit policy makers, funders, and programme managers
- The importance of dynamic interactions between multiple system components is a core principle of sustainability science, but has not been emphasised in previous conceptual approaches to health-programme sustainability
- Systematic review of studies investigating aspects associated with health-programme sustainability identified a wide range of factors, including context, resource availability, specific influences, and dynamic interaction between factors
- A model of health-programme sustainability based on context and resource availability, encompassing health concerns, interventions, and drivers, and emphasising dynamic interactions between components is proposed
- The proposed model can be used for programme planning and assessment. Prospective assessment of the utility of the proposed model in these tasks is needed

Panel 1: **Perspectives on health-programme sustainability**

Normative definitions of sustainability[2,4,5]

- Maintenance of health benefits[6–8]
- Continuation of health programmes[9–14]
- Institutionalisation of programmes within organisational systems[6,7,15]
- Community capacity[6,9,13,16,17]
- Multidimensional:
  - "The ability of a project to function effectively, for the foreseeable future, with high treatment coverage, integrated into available health care services, with strong community ownership using resources mobilised by the community and government."[18]
  - "The long term ability of an organisational system to mobilise and allocate sufficient and appropriate resources (manpower, technology, information and finance) for activities that meet individual or public health needs and demands."[19]

Factors affecting sustainability[2,5,19]

- Aspects of programme design and implementation (eg, goal, duration, governance, financial and delivery arrangements, related training, and involvement of local stakeholders)
- Attributes of the organisational setting (eg, institutional effectiveness, integration with existing programmes, congruency of programme with organisational mission, leadership, and presence of a programme champion)
- Factors in the broad environment (eg, nature and stability of the socioeconomic and political environment, community participation, market forces, and relevant laws)

Targets and interventions to promote sustainability[20,21]

- Individual (eg, education and training to promote individual change in knowledge, attitudes, beliefs, and behaviour)
- Organisational (eg, change in organisational policies and practices, such as continuous quality improvement or improved access, that affect changes in individual behaviour)
- Community action (eg, social action to create new partnerships to affect organisations and redistribute resources)
- System (eg, social advocacy for legislative change to affect community, organisational, and individual levels of social organisation)

discrepancies about inclusion, exclusion, data extraction, or classification until consensus was reached.

We synthesised the perspectives on sustainability and factors identified as being associated with programme sustainability into a conceptual framework using a consensus approach. Finally, the conceptual framework informed the development of an approach to planning for health-programme sustainability, which was illustrated with case studies drawn from the authors' experience.

Perspectives on health-programme sustainability

Our search yielded 1506 citations, from which we identified 145 articles about health-programme sustainability.

The simplest definition of sustainability is the 'capability of being maintained at a certain rate or level'. As Greenhalgh et al[3] showed in their review of diffusion of innovations in service organisations, and Shediac-Rizkallah and Bone[2] articulated in a model of sustainability, different research traditions and perspectives may view complex concepts such as sustainability differently (panel 1). For example, a health-promotion perspective has emphasised sustainability as the maintenance of health benefits over time. A focus on organisational change and innovation has instead led to a definition of sustainability as the ongoing delivery of health programmes, which may be measured by the longevity of independent projects, or how well programmes become institutionalised in organisations or health and social systems. A community development perspective has emphasised sustainability as the capacity of communities and individuals to maintain changes in behaviour. These diverse definitions of sustainability—sustained health outcomes, continued programme activities, or increased community capacity—have led to diverse approaches to planning for and monitoring sustainability, and prompted broadly inclusive multidimensional definitions from WHO[18] and others.[19]

In parallel with normative definitions, conceptual frameworks have sought to identify factors affecting sustainability (panel 1). These factors include aspects of programme design, attributes of organisations, and contextual factors, such as local health policy and social, cultural, and environmental characteristics.[2,4] These factors are likely to interact, and evaluative frameworks need to be multifaceted, and programme, institution, and context-dependent.[5] Other authors have taken the approach of defining targets for interventions or strategies to promote sustainability.[20,21]

Empirical assessments of health-programme sustainability

We identified 84 empirical assessments of programme sustainability, two-thirds of which reported a measure of sustainability over a discrete time. 24 reports were from low-income and middle-income countries, or disadvantaged populations in high-income countries (table 1). Studies from high-income countries that were sustained for 2 years or more after initial funding ended are reported in table 2. Four reviews that address sustainability of several programmes are included in table 3.

We found that empirical studies have approached sustainability from various different perspectives, and have used various qualitative and quantitative research methods. A wide range of factors have been associated with sustainability.

Many fit well in the broad categories of programme design, organisational setting, or broad environment as proposed by Shediac-Rizkallah and Bone.[2] Other identified factors, however, address interaction between the programme and key stakeholders (eg, tailoring an intervention to an issue, the context, and the providers, showing achievement of goals), or planning for evolution of these interactions over time (eg, integrating a programme into established structures, strengthening institutions, and ensuring adaptability). These dynamic

	Programme description	Assessment period	Measures of =sustainability	Factors thought to be associated with programme sustainability
Visruratna (1995)[22]	Improvement of sexual health in sex workers in Chiang Mai (Thailand) through free condom supply, small-group training, and education about condom use	1 year	Refusal rate of sex without a condom (CB)	Endorsement by brothel owners; full participation of sex workers; and recruitment of experienced sex workers to act as mentors
Lee (1995)[23]	Improvement of nutrition in a remote Australian Aboriginal community by education of elderly people	4 years	Nutritional intake (H)	Increased community nutritional awareness; elderly people as programme initiators and champions, quality and appropriateness of food supply; and community ownership and tailored intervention
Lafond (1995)[24]	Save the Children Fund research on sustainability of health systems in Nepal, Uganda, Pakistan, Ghana, and Vietnam	Various	Health systems (S)	Investment strategies correspond with environmental conditions and do not clash with them; investment practices oriented to the development needs of the health system rather than the institutional needs of donors and health ministries
Knippenberg (1997)[25]	Primary health care including expanded programme of immunisations in west Africa (the Bamako Initiative)	5 years	Primary-care services and immunisations (S)	National commitment; drug policies compatible with development of primary health care; decentralised primary-health-care decision-making and management of community resources; community-financed services; access to the poorest; clear objectives and performance indicators; institution and capacity building at all levels; and building alliances
Hii (1996)[26]	Control of malaria in rural Malaysia by training community volunteers, and provision of simple diagnostic and treatment kits	4 years	Number of slides obtained (S); malaria incidence and mortality (H)	Incentives for volunteers; state and district political support; budgetary restrictions; supervised training of volunteers; effectiveness and drug resistance; volunteers and community ownership; and monitoring and assessment
Hoque (1996)[27]	Reduction of water-borne infectious diseases in rural Bangladesh by provision of water pumps, pit latrines, and hygiene education	5 years	Persistence of access to water pumps and latrines (S); knowledge related to disease transmission (CB); incidence of diarrhoeal diseases (H); quality of life (H)	Provision of crucial infrastructure, such as spare parts for water pumps
Wong (1998)[28]	Improvement of sexual health in Singaporean sex workers by empowering them to refuse unprotected sex	2 years	Condom use; unprotected sex refusal (CB); gonorrhoea prevalence (H)	Mobilisation of sex-worker peer group; Ministry of Health support; and involvement of sex workers in planning and monitoring
Eliason (1999)[29]	Chronic-disease prevention in northwest Cameroon by appointing a village health committee to distribute funds for community-led health priorities	17 years	Active status of village health committee (CB)	Support from traditional rulers; accountability to village health committee; no embezzlement by promoter or village health committee; and promoter behaviour acceptability
Rowley (2000)[30]	Chronic-disease prevention in a remote Australian Aboriginal community by education, regular physical activity, and cooking classes	2 years	Health measures (body-mass index and impaired glucose tolerance) (H); percentage of people attempting dietary change (CB); and physical activity (CB)	Community education and mobilisation; funding of a diabetes nurse educator; and community-based programme development
McDermott (2003)[31]	Improved diabetes care in remote Australian Aboriginal communities by healthworker-run registers, recall and reminder systems, care plans, and specialist outreach	3 years	Care processes (S); clinical measures (H)	Appropriate management structures; clinical support; and structured care processes
Gruen (2002)[32]	Improvement of access to specialist services in remote Australian Aboriginal communities by specialist outreach visits	3 years	Number of consultations (S)	Sufficient resources and staff; integrated with other programmes; not dependent on one person; responds to and accountable to needs and demands; multidisciplinary framework centred in primary care; well-coordinated; assessed regularly; uses training opportunities
Tannenbaum (2002)[33]	Case detection of tuberculosis in Ecuador by sputum-smear microscopy, and treatment with short-course chemotherapy, monitoring and assessment	3 years	Patient cure (H), treatment completion (S)	Commitment of the inheriting institution to sustain the project; target group involvement in programme design and assessment; technical and managerial capability of recipient countries; resource availability; and health-worker skills
Wong (2002)[34]	Reduction of scabies infections in a remote Australian Aboriginal community by education, mass screening, and treatment	15 months	Scabies prevalence (H)	Community ownership and involvement in activities; women learning to do screening; financial support; and community ownership and tailored intervention
Ah Kit (2003)[35]	Chronic-disease prevention in a remote Australian Aboriginal community by promoting health-worker roles, extending preventive health programmes, education, and self-assessment	15 months	Service use (S); quality of life, clinical indicators (H)	Community awareness and participation; staff turnover; consumer group discussions, feedback, review, and redevelopment; and culturally appropriate
Jana (2004)[36]	Improvement of sexual health in Indian sex workers by education outreach recognition, and treatment	12 years	HIV and sexually transmitted infections incidence (H); condom use (CB); unprotected sex refusal (CB); literacy programmes (CB)	Political advocacy, sex-worker empowerment; access via peer group; and monitoring and review

(Continues on next page)

	Programme description	Assessment period	Measures of sustainability	Factors thought to be associated with programme sustainability
(Continued from previous page)				
Wakerman (2005)[37]	Chronic-disease management in remote Australian Aboriginal communities through community-based self-management education	26 months	Chronic disease self-management (CB)	Five broad themes of promoters and inhibitors of sustainability: contextual factors; community engagement; systems flexibility and adaptability; information systems availability and effect; and human nature of health care and policy
Edwards (2006)[38]	Improvement of maternal and child health in the Yunnan Province (China) by health-worker training, referral system, participatory monitoring, and assessment	6 years	Mortality rates (H); training of health workers (CB)	Programme champion; local officials' support; staffing levels; institutionalisation into local health system; and adaptation to local conditions
Amazigo (2007)[39]	Prevention of river blindness in Cameroon, Uganda, Nigeria, and Tanzania by community-directed ivermectin treatment	3–5 years	Leadership, human resources (CB); drug supply, treatment coverage (S)	Leadership; advocacy; community mobilisation; cash and in-kind incentives; monitoring and supervision; drug supply and distribution; financial, human, and material resources; local adaptation; and local leadership
Gurtler (2007)[40]	Chagas' disease prevention in Argentinian rural villages by community-wide insecticide spraying	21 years	Continuance of spraying (S); domestic infestation, infection rates (H)	Community involvement; locally nominated leaders; provision of insecticide; supervised distribution; local adaptation; and local leadership
Israr (2006)[41]	Improving primary health care in Pakistan by training, construction and repair of buildings, and procurement of equipment, medicine, furniture, and vehicles	6 years	Community participation and democratic decision-making (CB); institutionalisation of health teams (S)	Good governance; conducive organisational culture; prior-consensus building; participatory planning; community involvement; political commitment; and appropriate project management
Rosenberg (2008)[42]	Improving child health in southern Africa by a programme addressing orphans and children made vulnerable by HIV/AIDS	Various	Programme services (S)	Partnership between non-governmental organisations and local and national government agencies
Sebotsa (2007)[43]	Prevention of iodine deficiency in Lesotho by universal salt iodisation legislation	2 years	Prevalence of adequate iodine concentration (urine test) (H)	Political commitment; public education and social mobilisation; industry cooperation; national coordinating body; and enforceable legislation
Toledo Romani (2007)[44]	Dengue fever control in Santiago de Cuba by participatory action behaviour modification programmes	2 years	Maintenance of effects (H); level of institutionalisation (S); and continuity of activities through capacity building (CB)	Community education, resistance to change; other adequate services (eg, waste collection); organisational capacity; and community ownership and tailored intervention
Vernon (2007)[45]	Improvement of access to vasectomy services in Guatemala by printed education materials, community education, training health teams	11 months	Provision of services after project completion (S); number of vasectomies done (H)	Financial resources; staffing and training; and quality control

*S=services. H=health effects. CB=capacity building.

Table 1: **Empirical studies of programme sustainability for low-income and middle-income countries, and disadvantaged populations in high-income countries**

aspects seem to have been given less emphasis than structural characteristics in previous perspectives on sustainability.

Putting it together: an integrated approach for health-programme sustainability

In 1990, Bossert[4] considered the factors that promote sustainability of American aid projects in Central America and Africa (table 3). Since Shediac-Rizkallah and Bone's aetiological model of programmatic, organisational, and environmental factors,[2] Evashwick,[59] Pluye,[60] and Scheirer[5] have made important contributions on the basis of their reviews of empirical research, although none included programmes in low-income and middle-income countries (table 3). These reviews have also emphasised the importance of stakeholder interaction and programme evolution.

This theme is further developed by another set of articles identified in our search: those that drew parallels between global health challenges, of which sustaining successful health programmes is one, and challenges of environmental sustainability and sustainable human development.[61,62] Endeavours to expand knowledge about sustainable development have been labelled sustainability science by the US National Research Council (panel 2).[63]

Underpinning sustainability science is the concept of ecosystem, in which living organisms are continually engaged in a set of highly inter-related interactions with every other element constituting the environment in which they exist.[65] Ecosystems are forms of complex systems, in which the organisation and interaction of components of the system are as important as the components themselves. Furthermore, in health-care systems such interactions are not static and constant. Rather, they are dynamic processes and components may adapt to new conditions.[66] These dynamic inter-relations have been identified in articles included in our review, and are consistent with the conceptual approach to sustainability developed within the field of sustainability science.

Reconsideration of health programmes as elements embedded in complex systems emphasises the dynamism across time and place of interactions between programmes, communities, and other stakeholders. In

	Programme description	Assessment period	Measures of sustainability	Factors thought to be associated with programme sustainability
Goodman (1989)[46]	Health promotion in the USA by community-based programmes addressing risk behaviours and health practices	3 years	Continued programme activities (S)	Standard operating routines; critical precurser conditions; mutual adaptation of actor's aspirations; programme champion; mutual adaptation of programme and organisational norms; and fit with organisation's mission and core operations
Bracht (1994)[9]	Improvement of cardiovascular health in Minnesota (USA) through a heart health programme involving establishment of local boards, community organisation, training, and volunteers	3 years	Continuation of programmes post-funding (S)	Early planning of incorporation into community; engage community leaders and boards; communities modifying programmes to meet changing needs and interests; support structure that regularly revises, repackages, and re-sells programmes in the context of competitive effects; and local board involvement in planning and implementation
Goodson (2001)[47]	Institutionalisation of office-based tools for preventive services by primary-care providers in USA	6 years	Use of tools (S)	Institutional strength; integration within external programmes; programme visibility; planning for funding termination; and programme champion in middle-upper level management
Plochg (2006)[48]	Community-based integrated care initiatives in Netherlands	30 years	Collaborative partnerships (CB)	Collaborative partnerships; active health-system policy-making; incentive structures; and population-based performance measures
Scheirer (1990)[49]	Improving dental hygiene in the USA by school-based fluoride mouth-rinse programme	6 years	Adoption of programme elements (S)	Political influences and strong interpersonal communications; programme champion; and initial and continuing involvement of external health sources in administering the programme
Whitford (2004)[50]	Prevention of diabetic complications in UK general-practice clinics by a multifaceted, diabetes service in primary and secondary care	10 years	Documentation of clinical data (S); clinical indicators (H)	Multifaceted rather than simple interventions
Barnett (2004)[51]	Falls-related injury prevention in rural Australia by a multifaceted, community-based falls prevention programme	4 years	Awareness of programme, behaviour change (CB); health-staff practice changes (S)	Engage health-professional groups and shire councils; volunteers; routinisation; compatability with other projects
Elder (1998)[52]	Improving nutrition in a Latino community in California, USA, by a behaviour change programme	4 years	Institutionalisation of project interventions (S)	Close fit with mission of adopting agency; programme champion within agency; resulted in sufficient benefits for the agency; and sustainable at minimmal costs
Nilsen (2005)[10]	Reducing injury-related harm in Sweden by community-based prevention programmes	9–28 years	Continuity of programme (S)	Financial resources and volunteers; human and relational resources such as leadership skills, knowledge sharing between sectors, collaborative trusting relationships with decision makers, avoiding dependence on an individual
Baum (2006)[53]	Improvement of population health in Adelaide (Australia) by a multisectoral, multilevel, multifaceted initiative (WHO healthy cities)	18 years	Programme activities (S)	Community involvement; inspirational leadership; competing demands; staffing; funding; and local adaptation
Blasinsky (2006)[54]	Detection and treatment of late-life depression in US primary-care clinics by joint case management	12 years	Continuation of all or part of the multifaceted depression-care model (S)	Success of the intervention (documented by outcome data); organisation's support of collaborative care models; availability of trained staff; and funding
Lodl (2002)[55]	Reduce youth at risk in rural midwestern USA by development of coalitions within local communities	5 years	Continuation of coalition (CB)	Bring together wide variety of entities; begin work with specific goal for first project; good communication among coalition members; minimise duplication of services; someone responsible for maintaining coalition; youth membership; and develop skills at securing funding
Stroul (2007)[56]	Improved care to children and adolescents with emotional disorders in USA by development of federally-funded systems of care	10 years	Sustained systems of care (CB)	Include key stakeholders; inter-agency partnerships; local commitment; ongoing leadership; training; advocacy; programme champion; infusion into larger service system; positive evaluation data; state commitment and involvement; supportive policies; engaged political leaders; and state and federal financial support
O'Loughlin (1998)[57]	Community-based cardiovascular disease risk-factor reduction programmes in Canada	10 years	Permanence of the programme (S)	Programme champion; modifications able to be made to intervention; not relying on paid staff; and good intervention-provider fit
Lee (2007)[58]	Treatment of depression in US primary-care clinics by care managers in primary care supervised by specialist	3 years	Access to care (S)	Practice ownership of programme; funding availability

*S=services. H=health effects. CB=capacity building.

Table 2: **Empirical studies of programme sustainability in high-income countries sustained for 2 years or more after the initial funding period**

particular, it recognises that much depends on powerful stakeholders and how users respond to new programmes and services.[67] The complex systems approach encourages concepts such as equilibrium, connectivity, alignment, and adaptation.

Drawing upon existing conceptual frameworks and studies of programme sustainability, we developed a unifying model of health-programme sustainability that includes health concerns of a population, programmatic interventions implemented to address the identified health concerns, and the positive and negative drivers of these programmes (figure). The drivers have positive or negative effects on the programme's implementation, effectiveness, and durability. They include the many

	Reviewed empirical research	Concepts regarding programme sustainability
Bossert (1990)[4]	Five health projects in Central America and Africa	Effectiveness in reaching clearly defined goals and objectives; integrated activities into established administrative structures; gained substantial funding from national sources during the project life; negotiated project design with a mutually respectful process of give and take; included a strong training component; tailored to, and perhaps develop aspects of, the context; and strengthened institutions
Evashwick (2003)[59]	Health and social support to elderly people in USA	Importance of leadership, financing, organisational structure, governance, marketing, and evaluation or research
Pluye (2004)[60]	Health-promotion initiatives in North America	Institutionalisation is a combination of organisational routines and institutional stardards: three degrees of sustainability—weak (absence of routine), medium (non-standard routines), and high (standardised routines); planning for sustainability needs to start early
Scheirer (2005)[5]	Review of studies of sustainability in USA and Canada	Five important factors: a programme can be modified over time; a champion is present; a programme fits with its organisation's mission and procedures; benefits to staff members or clients are readily perceived; and stakeholders in other organisations lend support

Table 3: **Reviews of multiple programmes and factors relating to sustainability**

Panel 2: Sustainability science

Sustainability science encompasses scientific endeavours with a common focus on: (i) dynamic interactions between nature and society, recognising that one shapes the other and that understanding individual components of nature–society systems provides insufficient knowledge about the behaviour of the systems themselves; (ii) being issue-driven, with the goal of creating and applying knowledge in support of decision making for sustainable development; and (iii) ensuring that the knowledge is useful by having it coproduced through collaboration between researchers and practitioners.[62–64]

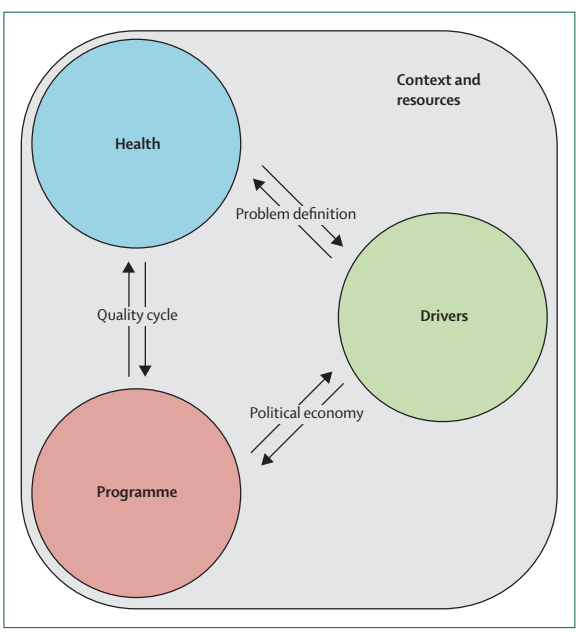

Figure: **A system for sustainable health programmes**
A health programme functions as a complex system, the key components of which are health concerns, programme elements, and drivers of the programme (both positive and negative) that interact in important ways with each other, and are situated in a particular context with defined resource availability.

stakeholders, especially funders, managers, policy makers, and community leaders who interact with the programme and who also respond to other programmes and to social, cultural, political, and economic influences. The model emphasises the importance of the multidimensional, interdependent, and dynamic nature of health-programme sustainability.

Health concerns of a population, programme components, and drivers of the programme are situated within a context defined by various sociocultural, political, geographical and health-system characteristics, and by the availability of resources. Although they might evolve or be changed as a result of programmes, these characteristics are often relatively fixed and might define the limits of what is possible in the short term.

The first important interaction for health-programme sustainability is the bidirectional relation between health of a population and programmes implemented within the population (figure). It is analogous to a programme quality cycle, in which health status informs programme design, and the effect of the programme modifies the health status of the population. Well-described methods for optimising and measuring programme quality exist—ie, a clear understanding of health needs, programme design closely aligned to these needs, quantifiable effect on the health status of the population, and timely modifications to programme design based on evolving understanding of programme effectiveness and changes in health needs. These are important foundations for programme sustainability. Programmes that positively affect the health of a population and can show this are more likely to be sustained. Planning for sustainability is therefore based on sound programme design, monitoring, and assessment and ongoing evidence-based programmatic refinements.

The second important interaction for health-programme sustainability is understanding and affecting the relation between a programme and its drivers (figure). From resource mobilisation to programme delivery, the flow and direction of financial resources depend on many factors: donor funds are affected by the status of the economy and the opinion of taxation or other base from which they are derived; the health and competing priorities of host governments, donor governments, multilateral institutions, and those of the implementing organisations that shape and deliver the interventions; and, ideally, the perspectives of the beneficiaries they

seek to help. These effects are more complex than simply positive or negative, and have an impact not only on the existence, scope, and duration of programmes, but also on the specific aspects of their design. Health-system analyses emphasise the importance of these effects, or drivers, on health programmes, but a comprehensive understanding of health-programme sustainability should also include an understanding of the opposite relation—ie, the programme's ability, through demonstration of positive results or lack thereof, to affect ongoing resource mobilisation. These bidirectional relations constitute the political economy of health and are mediated by the flow of resources and benefits.

In many countries, lack of resources is a major constraint on all programmes, but well-characterised examples of countries or regions that have achieved substantial improvements in the health of their populations by prioritising health development exist. This result shows the importance of optimising the distribution of resources, even in severely resource-constrained settings. Health programmes that depend on international funding are hard to sustain because of the complex relations of sustained resource flow, increasing the difficulty in aligning health programmes and their powerful drivers. Perceived benefits accruing to stakeholders improve the possibility that resources will continue to be mobilised to sustain a certain health programme, but this is sensitive to the stakeholders' power and priorities.

The third important interaction for health-programme sustainability is the relation between health concerns and health-programme drivers as mediated through the way that stakeholders identify, define, and prioritise health problems (figure). The knowledge of how various stakeholders respond to health issues relies on understanding how and why issues are formulated. The health status of a population can be defined by various health metrics, such as burden of disease,[68] and ideally a deficiency in the health status of a population leads to the generation of demand and availability of resources for an intervention. However, problem definition is partly in the eye of the beholder, because the definition and prioritisation of issues in hierarchies of health needs is usually a subjective process that differs between stakeholders. Furthermore, the relation between drivers and health concerns is complex and bidirectional. For example, powerful stakeholders might modify the perceived health status of a population by influencing the generation of population health data and the way these data are presented. Transparency and objectivity in health-needs assessment and data use are goals that could therefore help meaningful programme planning.

In the model that we propose, clarification and alignment of components are crucial to these tasks, and form the basis of the questions for programme planners (panel 3). Initial questions relate to definition of the relevant components, beginning with key aspects of the context and resource availability. Local factors affect the vulnerability or resilience of the system. Pre-emptive identification of important differences between contexts and assessments of how components of the system could be modified is likely to promote sustainability across diverse times and places.

The health problem of interest, the programme design and implementation strategy, and the range of stakeholders engaged with or affected by the programme should then be clarified, even tough this task might be difficult.

Some other questions help to identify and plan the dynamic relations between components. The first group focuses on problem definition. Many interpretations of need might exist and who the interpreter is will have a

***Panel 3:* Planning for sustainability**

Are the components of the system well defined?

- What is the health concern that is being and will be addressed? And how might it change over time as a result of the programme or other factors?
- What is the design of the programme? And how has it been or will it be implemented?
- What factors and which key stakeholders, especially funders, managers, policy makers, and community leaders have affected or will affect the programme, and what drives them?
- What are the limitations and opportunities created by the organisational setting, the broader context, and availability of resources?

Are the interactions between components understood?

Problem definition (alignment of drivers and health concern):

- Is the health concern documented?
- Is the health concern recognised by the drivers of the programme?
- Are there appropriate steps to include a beneficiary perspective?
- Are there appropriate steps to gather and report data for health needs and programme effectiveness?

Quality cycle (alignment of programme and health concern):

- Is the programme design evidence-based and appropriately targeted at the health concern or its determinants?
- Do the programme indicators address the health concern, its determinants, the programme's implementation and effect, and stakeholders' views and experiences?
- Is a process in place to capture emergent tacit knowledge and emergent research findings from other jurisdictions about the health concern, its determinants, the programme's implementation and impact, and prompt periodic reappraisals?
- Is there a dynamic programme design in place so that programme elements can be adapted or dropped if features of the health concern or its determinants shift, if barriers to the achievement of its anticipated effects cannot be addressed, or if the programme's anticipated effects are not realised?

Political economy (alignment of programme and its drivers):

- How do key stakeholders influence the programme and what guides their decisions?
- Is the net sum of drivers supporting the programme's initiation and continued development?
- How can the negative programme drivers be addressed?
- What means exist for informing both positive and negative programme drivers of changes in the health concern, its determinants, barriers to achievement of anticipated effects, or shortfalls in realising anticipated effects and engaging them in supporting change?

Panel 4: **Case studies**

Specialist outreach to remote Indigenous communities in Australia

Australia's Northern Territory is a vast sparsely populated region with many small disadvantaged Indigenous communities and only two hospitals with medical specialists. Facilities in communities are basic and, although remote Indigenous Australians have much higher rates of acute and chronic illness than other Australians, community residents face considerable geographic, poverty, cultural, and language barriers accessing hospital-based care. The Specialist Outreach Service is an Australian government-funded programme to overcome poor access to specialist ophthalmological, ear, nose, and throat, gynaecological, and general surgical care by providing regular clinics for consultations and minor procedures in the community setting. Communication between stakeholders was eased by central coordination, and data gathering helped to ensure a robust quality cycle. In the first 3 years, substantial improvement in indicators of access was shown, the need for remote people to travel was reduced, and specialists, health workers, and patients expressed positive attitudes towards the service.[69]

In the early years of the service, especially at the time it was launched, national and territory goverments, health-service managers, professional medical societies, Indigenous organisations, and specialists themselves were powerful positive drivers because they celebrated a seemingly worthwhile initiative and enjoyed good publicity. Indigenous communities and remote clinical staff were supportive but less influential. Throughout the programme's inception and establishment, however, negative drivers existed; competing demands on regional policy makers for finite resources and fatigue from a small number of specialists involved who were balancing hospital roles with long-distance travel and rudimentary consulting conditions. As the enthusiasm of powerful stakeholders lessened or as new people came into powerful positions, the negative drivers became very important. When specialists ceased undertaking remote-area visits, some after a decade of outreach activity, resources were not targeted to restoration of the service to previous levels, and downsizing occurred. Now, the service provides an important, but smaller scale, service to remote communities.

The changing balance of drivers is common in the early years of health programmes. Especially if staff turnover is high, management of relations and effective use of performance data can be very helpful in maintaining enthusiasm from key stakeholders, resulting in resource flow, institutional support, and other benefits.

Towards the Millennium Development Goals (MDGs) in Rwanda

On Sept 30, 2000, 189 world leaders, including President Paul Kagame, attended the UN Millennium Summit and made a commitment to address the world's most pressing development needs by 2015. Much remains to be done to achieve the MDGs, especially in sub-Saharan Africa.[70] Rwanda has leadership in making sustained progress and deserves close examination.

Rwandan policy makers could define their issues in a dynamic evidence-based manner with data from periodic demographic health surveys, households' living conditions surveys, and health and other service data. With presidential leadership, the government has explicitly recognised dynamic interactions between poverty, education, health, sex, and the environment, and embraced interdisciplinary approaches to address these challenges.[71] The Ministry of Health continues to evolve to optimise its interdisciplinary coordination and policy-making structures to ensure that the health MDGs (reduction of child mortality; improvement of maternal health; and fight against HIV/AIDS, malaria, and other diseases) are aggressively addressed, drawing on evolving scientific knowledge and programme data, engaging all stakeholders and with an accompanying resource mobilisation strategy.

Key drivers include host government, donors, and civil society groups. Drivers also shift over time, with the emerging private sector and district government having increasingly important roles, and maturing civil-society structures more able to represent their constituencies. High donor-dependence drivers seem to be in a healthy equilibrium because of factors such as: strong government leadership; explicit seeking of beneficiary perspective in methods of problem definition; civil-society participation in programme implementation; culture of data use to drive evidence-based decisions; congruence between national and international priorities and hence funding; dynamic, timely, evidence-based policy and programming; use of emergent research, programme knowledge, technology, Rwandan programme monitoring, and evaluation data; tracking of impact data, and output or outcome data; and clear coordination structures at national and local levels bringing key stakeholders together.

Rwanda continues to make great progress towards achieving the health MDGs, overcoming considerable obstacles. Between 2000 and 2008, mortality of children younger than 5 years has fallen by 49% to 103 deaths per 1000 live births, with improvements in attended delivery and access to prevention of vertical HIV transmission services, and huge reductions in malaria-related mortality. HIV and malaria goals are on track, with a decline in HIV prevalence and substantial progress made towards achieving global access to HIV treatment. Multifaceted sex education and health interventions are used to reduce maternal mortality, with a 30% reduction between 2000 and 2005; however, achievement of this MDG needs further scale-up and innovations, such as current emphasis on couple involvement, family planning, and expanded health-insurance coverage.[72,73]

Underpinning the ongoing success in Rwanda is an explicit recognition of the dynamic nature of the health ecosystem coupled with an evidence-based approach to defining issues and programmatic solutions. This conceptual approach promotes a dynamic response because it recognises that interventions bring change to the system and thus new opportunities. An example is the recent innovation to have couples (not just women) attend antenatal care, enabling new prevention and care opportunities in negotiating couple HIV status and addressing sex barriers to institutionalised deliveries and birth spacing and family planning. Evidence-based approaches and results have also been successful in optimising resource use, and sustaining and expanding external funding.

bearing on driving the programme. Communities' definitions of their own need may differ substantially from definitions that derive from within health-care systems. Clarity about who is interpreting the health status helps to better understand programme drivers.

Some other questions engage the programme quality cycle to ensure and measure alignment of the programme with health needs. First, an assessment should be made of the alignment between the initial programme design and the health concern being targeted. Second, a monitoring

and evaluation system is needed, in which information is captured that reflects the health concern, the design of the intervention, and the views and experiences of stakeholders. This system includes ways to capture tacit knowledge and emergent research findings. Third, an assessment should be made of the degree to which new knowledge generated by the programme or from other programmes has been or will be used to modify implementation, and how this will affect alignment between the programme and health needs over time.

Another group of questions relate to the alignment between the programme and its drivers. These questions explore the flow of resources and benefits and underlying power dynamics. They encourage explicit activities that engage with different programme stakeholders, and seek to maximise the connections and positive exchange of resources and benefits between key stakeholders and the programme.

Panel 4 shows two case studies, in which the model is used to improve understanding of programme sustainability.

Conclusions

Despite many differences between health and environmental science, we showed that a useful conceptual understanding of health-programme sustainability can be derived from a synthesis of existing conceptual approaches to health-programme sustainability and evidence of associated factors, informed by conceptual approaches developed within sustainability science. We propose that health-programme sustainability is the ultimate manifestation of a complex web of inter-relations between health concerns, stakeholders, resources, and actions analogous to an ecosystem.

Sustainability is increased to the degree to which the components of the system are connected and aligned—an indication of system equilibrium. Unsustainable programmes are a form of disequilibrium, in which the health status of a population, the programme implemented within the population, and the drivers of the programmes are disconnected and misaligned. A programme that is well designed to affect health status is vulnerable, particularly to withdrawal of funding or community support, if it has neglected the importance of stakeholders driving or hindering the programme. Similarly, a programme that panders to key stakeholders at the expense of commitment to health improvement is likely to run out of support.

The proposed model has not been tested, and prospective assessment during programme planning and assessment of existing programmes is needed. However, the model is based on previous frameworks and empiric evidence of programme sustainability in high-income countries, and in low-income and middle-income countries, and is also grounded in the theoretical background emerging in environmental science about sustainability. The entities and concepts of previous frameworks are easily incorporated into this model. However, the interactions between components are now the main concern, emphasising the importance of ongoing cycles of reflection, planning, and action that are needed to make programmes sustainable.

The model should be useful for programme planners and assessors. It encourages broad conceptualisation of programmes, and may therefore help comprehensive planning. Definition of components is followed by definition and measurement of the interactions between them. Differences between sites and characteristics of programmes can be explored. As Scheirer has suggested,[5] assessment of sustainability is likely to be a multifaceted process, with results contingent on the specific programmes and contexts in which they are operating. Health-programme sustainability is therefore related to the general concept of local applicability, and health programmes need to be adapted to changing circumstances or different locations.[74,75] Together with the support of successful health programmes lie the challenges of enabling them to engage local and national populations in ways that facilitate growth.[61] Key questions are: can a health programme endure change in the local community or institutions? Can it be expanded to address a broader population? Can it be applied in different settings? And what issues are important in the identification, interpretation, and application of evidence about the programme?

All the elements of the system of health-programme sustainability are modifiable to a certain extent. Identification of modifiable factors could promote programme sustainability. At the same time, the identification of programmes or programme components that should not be sustained is important. Built into any programme, therefore, should be questions about planned obsolescence to identify triggers or tipping points for programme re-assessments to decommissioning programmes, or programme components that are no longer needed.[76] Some health programmes are short term and are not intended to be sustained, just as some structural, economic, or political contexts are so unfavourable that sustainability may not be an initial goal. Conceptualising sustainability as a characteristic of systems, however, should encourage planners to undertake explicit activities that engage with the range of programme stakeholders, strengthening the connections and promoting mutual benefits.[77] Many examples exist attesting successful and lasting institutionalisation of reforms derived from the interaction between programmes and key stakeholders, such as road traffic injury prevention,[78] community-based HIV prevention,[36] and national health-insurance reforms.[79]

Sustainability or its absence can be shown by quantification of the continuation of health benefits, interventions, or capacity over time, but understanding the determinants of sustainability needs exploration of

interactions between drivers and programme components in a particular context. Formal structures and relations are important, but so are informal relations that often guide human behaviour.[67] A broad conceptualisation of the components of a so-called health ecosystem, and the dynamic and complex inter-relation between these components opens up opportunities to assess and address factors that affect health-programme sustainability. Such an approach might promote the sustainability of health programmes and provide a robust framework within which new evidence can be framed.

Contributors

RLG conceived the paper. RLG and JHE wrote the paper, and all authors reviewed and contributed to the final version. RLG, JHE, PDL, MLN, and JNL developed the conceptual model. AP developed and did the searches, and RLG and CJM assessed, classified, and summarised the included studies. RLG and MLN supplied the case studies.

Conflict of interest statement

RLG is an author of one study included in the review. We declare that we have no other known conflict of interest.

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References

1 The Mexico Statement on Health Research. Knowledge for better health: strengthening health systems. Mexico City: the Ministerial Summit on Health Research, 2004.

2 Shediac-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Educ Res* 1998; **13:** 87–108.

3 Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and reccomandations. *Milbank Q* 2004; **82:** 581–629.

4 Bossert TJ. Can they get along without us? Sustainability of donor-supported health projects in Central America and Africa. *Soc Sci Med* 1990; **30:** 1015–23.

5 Scheirer M. Is sustainability possible? A review and commentary on empirical studies of program sustainability. *Am J Eval* 2005; **26:** 320–47.

6 Friedman AR, Wicklund K. Allies against asthma: a midstream comment on sustainability. *Health Promot Practice* 2006; **7** (suppl)**:** 140S–48S.

7 Stefanini A. Sustainability: the role of NGOs. *World Health Forum* 1995; **16:** 42–46.

8 McMichael AJ. Population health as the 'bottom line' of sustainability: a contemporary challenge for public health researchers. *Eur J Public Health* 2006; **16:** 579–81.

9 Bracht N. Community ownership and program continuation following a health demonstration project. *Health Educ Res* 1994; **9:** 243–55.

10 Nilsen P, Timpka T, Nordenfelt L, Lindqvist K. Towards improved understanding of injury prevention program sustainability. *Safety Science* 2005; **43:** 815–33.

11 Knippenberg R, Soucat A, Oyegbite K, et al. Sustainability of primary health care including expanded program of immunizations in Bamako Initiative programs in West Africa: an assessment of 5 years' field experience in Benin and Guinea. *Int J Health Plan Manage* 1997; **12** (suppl 1)**:** S9–28.

12 Lengeler C. From Rio to Iragua—sustainability versus efficiency and equity for preventive health interventions. *Trop Med Int Health* 1999; **4:** 409–11.

13 Sarriot EG, Winch PJ, Ryan LJ, et al. Qualitative research to make practical sense of sustainability in primary health care projects implemented by non-governmental organizations. *Int J Health Plan Manage* 2004; **19:** 3–22.

14 Humphreys JS, Wakerman J, Wells R. What do we mean by sustainable rural health services? Implications for rural health research. *Aust J Rural Health* 2006; **14:** 33–35.

15 Glaser EM. Durability of innovations in human service organizations: a case-study analysis. *Sci Comm* 1981; **3:** 167–85.

16 Farmer J, Lauder W, Richards H, Sharkey S. Dr John has gone: assessing health professionals' contribution to remote rural community sustainability in the UK. *Soc Sci Med* 2003; **57:** 673–86.

17 Mann S, Byrnes T. Capacity building and community enrichment: evaluation for sustainability. *Aust J Primary Health Interchange* 1999; **5:** 43–50.

18 WHO. Guidelines and instruments for conducting an evaluation of the sustainability of CDTI projects. WHO/APOC/MG/02-1. Ouagadougou: African Program for Onchoecerciasis Control, 2002.

19 Olsen IT. Sustainability of health care: a framework for analysis. *Health Policy Plan* 1998; **13:** 287–95.

20 Bailie RS, Si D, O'Donoghue L, Dowden M. Indigenous health: effective and sustainable health services through continuous quality improvement. *Med J Aust* 2007; **186:** 525–27.

21 Swerissen H, Crisp BR. The sustainability of health promotion interventions for different levels of social organization. *Health Promot Int* 2004; **19:** 123–30.

22 Visruratna S LC, Sirhorachai A, Mandel JS. 'Superstar' and 'model brothel': developing and evaluating a condom promotion program for sex establishments in Chiang Mai, Thailand. *AIDS* 1995; **9** (suppl 1)**:** S69–S75.

23 Lee AJ, Bonson AP, Yarmirr D, O'Dea K, Mathews JD. Sustainability of a successful health and nutrition program in a remote aboriginal community. *Med J Aust* 1995; **162:** 632–35.

24 Lafond AK. Improving the quality of investment in health: lessons on sustainability. *Health Policy Plan* 1995; **10:** S63–76.

25 Knippenberg R, Soucat A, Oyegbite K, et al. Sustainability of primary health care including expanded program of immunizations in Bamako initiative programs in West Africa: an assessment of 5 years' field experience in Benin and Guinea. *Int J Health Plann Manag* 1997; **12:** S9–28.

26 Hii JL, Chee KC, Vun YS, Awang J, Chin KH, Kan SK. Sustainability of a successful malaria surveillance and treatment program in a Runggus community in Sabah, east Malaysia. *Southeast Asian J Trop Med Public Health* 1996; **27:** 512–21.

27 Hoque BA, Juncker T, Sack RB, Ali M, Aziz KM. Sustainability of a water, sanitation and hygiene education project in rural Bangladesh: a 5-year follow-up. *Bull World Health Organ* 1996; **74:** 431–37.

28 Wong ML, Chan KW, Koh D. A sustainable behavioral intervention to increase condom use and reduce gonorrhea among sex workers in Singapore: 2-year follow-up. *Prev Med* 1998; **27:** 891–900.

29 Eliason RN. Towards sustainability in village health care in rural Cameroon. *Health Prom Int* 1999; **14:** 301–06.

30 Rowley KG, Daniel M, Skinner K, Skinner M, White GA, O'Dea K. Effectiveness of a community-directed 'healthy lifestyle' program in a remote Australian aboriginal community. *Aust N Z J Public Health* 2000; **24:** 136–44.

31 McDermott R, Tulip F, Schmidt B, Sinha A. Sustaining better diabetes care in remote indigenous Australian communities. *BMJ* 2003; **327:** 428–30.

32 Gruen RL, Weeramanthri TS, Bailie RS. Outreach and improved access to specialist services for indigenous people in remote Australia: the requirements for sustainability. *J Epidemiol Community Health* 2002; **56:** 517–21.

33 Tannenbaum TN. Sustainable tuberculosis control. *Can Respir J* 2002; **9:** 387–88.

34 Wong LC, Amega B, Barker R, et al. Factors supporting sustainability of a community-based scabies control program. *Australas J Dermatol* 2002; **43:** 274–77.

35 Ah Kit JA, Prideaux C, Harvey PW, et al. Chronic disease self-management in Aboriginal communities: towards a sustainable program of care in rural communities. *Aust J Primary Health* 2003; **9:** 168–76.

36 Jana S, Basu I, Rotheram-Borus MJ, Newman PA. The Sonagachi Project: a sustainable community intervention program. *AIDS Educ Prev* 2004; **16:** 405–14.

37 Wakerman J, Chalmers EM, Humphreys JS, et al. Sustainable chronic disease management in remote Australia. *Med J Aust* 2005; **183** (suppl)**:** S64–S68.

38 Edwards N, Roelofs SM. Sustainability: the elusive dimension of international health project. *Can J Public Health* 2006; **97:** 45–49.

39 Amazigo U, Okeibunor J, Matovu V, Zoure H, Bump J, Seketeli A. Performance of predictors: evaluating sustainability in community-directed treatment projects of the African programme for onchocerciasis control. *Soc Sci Med* 2007; **64:** 2070–82.

40 Gurtler RE, Kitron U, Cecere MC, Segura EL, Cohen JE. Sustainable vector control and management of Chagas disease in the Gran Chaco, Argentina. *Proc Natl Acad Sci USA* 2007; **104:** 16194–99.

41 Israr SM, Islam A. Good governance and sustainability: a case study from Pakistan. *Int J Health Plann Manag* 2006; **21:** 313–25.

42 Rosenberg A Hartwig K, Merson M. Government–NGO collaboration and sustainability of orphans and vunerable children projects in Africa. *Eval Program Plan* 2008; **31:** 51–60.

43 Sebotsa ML, Dannhauser A, Jooste PL, Joubert G. Assessment of the sustainability of the iodine-deficiency disorders control program in Lesotho. *Food Nutr Bull* 2007; **28:** 337–47.

44 Toledo Romani ME, Vanlerberghe V, Perez D, et al. Achieving sustainability of community-based dengue control in Santiago de Cuba. *Soc Sci Med* 2007; **64:** 976–88.

45 Vernon R, Solorzano J, Munoz B. Introducing sustainable vasectomy services in Guatemala. *Int Fam Plan Perspect* 2007; **33:** 182–87.

46 Goodman RM, Steckler A. A model for the institutionalisation of health promotion programs. *Fam Community Health* 1989; **11:** 63–78.

47 Goodson P, Smith MM, Evans A, Meyer B, Gottlieb NH. Maintaining prevention in practice: survival of PPIP in primary care settings. *Am J Prev Med* 2001; **20:** 184–89.

48 Plochg T, Delnoij DMJ, Hoogdoorn NPC, Klazinga NS. Collaborating while competing? The sustainability of community-based integrated care initiatives through a health partnership. *BMC Health Serv Res* 2006; **6:** 37.

49 Scheirer MA. The life cycle of an innovation: adoption versus discontinuation of the fluoride mouth rinse program in schools. *J Health Soc Behav* 1990; **31:** 203–15.

50 Whitford DL, Roberts SH, Griffin S. Sustainability and effectiveness of comprehensive diabetes care to a district population. *Diabet Med* 2004; **21:** 1221–28.

51 Barnett LM, Van Beurden E, Eakin EG, Beard J, Dietrich U, Newman B. Program sustainability of a community-based intervention to prevent falls among older Australians. *Health Promot Int* 2004; **19:** 281–88.

52 Elder JP, Campbell NR, Candelaria JI, et al. Project Salsa: development and institutionalisation of a nutritional health promotion project in a Latino community. *Am J Health Prom* 1998; **12:** 391–401.

53 Baum F, Jolley G, Hicks R, Saint K, Parker S. What makes for sustainable Healthy Cities initiatives? A review of the evidence from Noarlunga, Australia after 18 years. *Health Promot Int* 2006; **21:** 259–65.

54 Blasinsky M, Goldman HH, Unutzer J. Project IMPACT: a report on barriers and facilitators to sustainability. *Adm Policy Ment Health* 2006; **33:** 718–29.

55 Lodl K, Stevens G. Coalition sustainability: long-term successes and lessons learned. *J Extension* 2002; **40:** 1.

56 Stroul BA, Manteuffel BA. The sustainability of systems of care for children's mental health: lessons learned. *J Behav Health Serv Res* 2007; **34:** 237–59.

57 O'Loughlin J, Renaud L, Richard L, Sanchez-Gomez L, Paradis G. Correlates of the sustainability of community-based heart health promotion interventions. *Prev Med* 1998; **27:** 702–12.

58 Lee PW, Dietrich AJ, Oxman TE, Williams JW Jr, Barry SL. Sustainable impact of a primary care depression intervention. *J Am Board Fam Med* 2007; **20:** 427–33.

59 Evashwick C, Ory M. Organizational characteristics of successful innovative health care programs sustained over time. *Fam Community Health* 2003; **26:** 177–93.

60 Pluye P, Potvin L, Denis JL. Making public health programs last: conceptualising sustainability. *Eval Progr Plan* 2004; **27:** 121–33.

61 Bloom BR. Sustainable health: a new dimension of sustainability science. *Proc Natl Acad Sci USA* 2007; **104:** 15969.

62 Forum on Science and Innovation for Sustainable Development. www.sustainability science.org (accessed July 16, 2008).

63 Clark WC, Dickson NM. Sustainability science: The emerging research program. *Proc Natl Acad Sci USA* 2003; **100:** 8059–61.

64 McMichael A. New visions for addressing sustainability. *Science* 2003; **302:** 1919–20.

65 Willis AJ. The ecosystem: an evolving concept viewed historically. *Funct Ecology* 1997; **11:** 268–71.

66 Plsek PE, Greenhalgh T. Complexity science: the challenge of complexity in health care. *BMJ* 2001; **323:** 625–28.

67 McPake B, Blaauw D, Sheaff R. Recognising patterns: health systems research beyond controlled trials. Health Systems Development Programme 2006. http://www.hsd.lshtm.ac.uk/publications/hsd_working_papers/recognising_patterns_web_version.pdf (accessed July 16, 2008).

68 Murray CJ, Lopez AD. The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. Cambridge: Harvard School of Public Health, 1996.

69 Gruen RL, Bailie RS, Wang Z, Heard S, O'Rourke IC. Specialist outreach to isolated and disadvantaged communities: a population-based study. *Lancet* 2006; **368:** 130–38.

70 UN. The Millennium Development Report. http://www.un.org/millenniumgoals/pdf/The%20Millennium%20Development%20Goals%20Report%202008.pdf. (accessed Oct 7, 2008).

71 UN. Millennium Development Campaign. Meeting the MDG goals: People Ask the President. Exclusive interview with Rwanda's President Paul Kagame. Mail and Guardian. http://www.mg.co.za/article/2008-09-30-meeting-the-goals (accessed Oct 7, 2008).

72 Institut National de la Statistique du Rwanda (INSR) and ORC Macro. Rwanda Demographic and Health Survey 2005. Calverton: INSR and ORC Macro, 2006.

73 Institut National de la Statistique du Rwanda (INSR) and ORC Macro. Rwanda Mini-Demographic and Health Survey 2007–8. Calverton: INSR and ORC Macro, 2008.

74 Lavis JN, Posada FB, Haines A, Osei E. Use of research to inform public policymaking. *Lancet* 2004; **364:** 1615–21.

75 Gruen RL, Morris PS, McDonald L, Bailie RS. Making systematic reviews more useful for policy-makers. *Bull World Health Organ* 2005; **83:** 480–81.

76 Elshaug AG, Hiller JE, Moss JR. Exploring policy-makers' perspectives on disinvestment from ineffective healthcare practices. *Int J Technol Assess Health Care* 2008; **24:** 1–9.

77 Buse K. Addressing the theoretical, ethical and practical challenges inherent in prospective health policy analysis. *Health Policy Plan* 2008; **23:** 351–60.

78 Peden M, Scurfield R, Sleet D, et al. World report on road traffic injury prevention. Geneva: World Health Organization, 2004.

79 Frenk J, Gonzalez-Pier E, Gomez-Dantes O, Lezana M, Knaul F. Comprehensive reform to improve health system performance in Mexico. *Lancet* 2006; **368:** 1524–34.