

Impacts of infectious diseases
on poverty –
What do we know and
what way forward?

Anita Blomfeldt

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Anita Blomfeldt				
Författarens befattning och adress				
Spesialbioingeniør Akershus Universitetssykehus, EpiGen, Boks 26, 1478 Lørenskog, Norge				
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Sammanfattning				
<p>Kampen mot infeksjonssykdommer og fattigdom er høyt prioritert på den globale agenda. Dårlig helse og fattigdom utgjør en ond sirkel som forsterkes av en "medisinsk fattigdomsfelle" grunnet økende sykdomsrelaterede utgifter kombinert med tap av inntekt fordi sykdom hindrer en i å arbeide. Evidensbasert kunnskap om sykdommenes konsekvenser for husholdenes velferd er påkrevet for å utarbeide adekvate intervensjoner og evaluere deres effektivitet.</p> <p>Denne masteroppgaven presenterer resultatene av en kritisk gjennomgang av publiserte studier som analyserer effekter av infeksjonssykdommer på rurale husholds evne til å nyttiggjøre seg av sine ressurser og generere inntekt i afrikanske land sør for Sahara.</p> <p>Litteraturgjennomgangen avdekket få relevante studier (bare 15), svak metodologisk kvalitet i geografisk begrensede studier og stor diversitet i studiedesign. Diversiteten gjorde det nesten umulig å sammenligne resultater og sammenfatte generelle konklusjoner. De viktigste forskningsmessige hindringene diskuteres og det foreslås anbefalinger for koordinering, standardisering og oppskalering av datainnsamling som muliggjør adekvat konsekvensanalyse. Eksperimentelle intervensjonsstudier anbefales både som ledd i prioriteringsprosesser, for å bedre intervensjoners kvalitet og effektivitet og for å unngå sløsing med tid og ressurser før stor-skala implementeringer.</p> <p>Sammenhengen mellom infeksjonssykdommer og fattigdom er kompleks og mangesidig og innbyr dermed til flerfaglige og tverrfaglige tilnærminger. Samarbeid mellom ulike fagområder som medisin, økonomi, sosiologi og geografi åpner for muligheter til å kombinere data på innovative måter for å frembringe nye perspektiver og innsikter med potensiale til å analysere infeksjonssykdommers effekt på hushold mer omfattende og helhetlig. Metodologisk standardisering og konsensus åpner for oppskalering av forskningen og for akkumulering av sammenlignbare resultater. Slik kan investeringer i forskning bidra til å få kontroll med infeksjonssykdommer og legge forholdene bedre tilrette for økonomisk vekst i utviklingsland.</p>				
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– Essay –

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Author				
Anita Blomfeldt				
Author's position and address				
Biomedical laboratory scientist Akershus University Hospital, EpiGen, Box 26, 1478 Lørenskog, Norway				
Date of approval			Supervisor NHV/External	
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Abstract

Combating infectious diseases and poverty are hot topics on the world development agenda. The vicious cycle of ill health and poverty is reinforced by a “medical poverty trap” relating to households being impoverished due to escalating illness-related out-of-pocket costs, especially in combination with loss of income due to incapacity to work. Evidence-based knowledge on the impacts of ill health on household welfare is essential to design adequate interventions and evaluate their efficiency.

This thesis presents the findings of a critical review of studies assessing the impacts of infectious diseases on households’ ability to utilize their resources and generate income in rural Sub-Saharan Africa.

The review revealed a dearth of relevant studies (merely 15), poor methodological quality in short-term geographically limited surveys, and large diversity in study design obstructing comparison of results and extraction of general conclusions. Major research obstacles are discussed and recommendations for coordination, standardization and scaling up of data collection that allows adequate impact assessment are suggested. Experimental intervention studies are recommended to improve quality and efficiency of interventions and guide prioritizing processes prior to large scale implementations to avoid waste of time and resources.

The linkages between infectious diseases and poverty are complex and multifaceted and thus imply multi- and interdisciplinary research approaches. Collaboration between various disciplines like health sciences, economics, geography and sociology give opportunities of linking data in innovative ways to provide new insights and perspectives that have the potential to analyse the impacts of infectious diseases on poverty in a more comprehensive manner. Methodological standardisation and consensus will enable us to accumulate comparable results and scale up research and thereby contribute to foundation of efficient interventions to accomplish sustainable improvements in health and significant reductions in poverty.

Key words

Infectious diseases, household economics, poverty, impact assessment methodology, interventions, Sub-Saharan Africa

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Article:

Impacts of infectious diseases on poverty in Sub-Saharan Africa –
What do we know and what way forward?

"He who has health has hope; and he who has hope has everything."

Arabian Proverb

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CMH	Commission on Macroeconomics and Health
GIS	Geographic Information Systems
HIV	Human Immunodeficiency Virus
ITN	Insecticide-treated mosquito nets
MDG	Millennium Development Goals
SSA	Sub-Saharan Africa
UN	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WTP	Willingness to pay

Preface

This Master of Public Health thesis consists of an article submitted to the journal Social Science and Medicine and a general overview placing the paper in a wider context. In the general part, I refer to the article as (Article) and all other references are referred to according to the Harvard system.

Introduction

Poverty reduction and health improvements are hot topics on the world development agenda. The traditional view that poverty reflects only on economic aspects measured commonly by income and consumption levels has changed towards a broader view looking at poverty as a multidimensional social phenomenon where health is a vital component. Nobel Prize economist Amartya Sen has influenced this alteration by drawing attention to the fundamental link between development and freedom, reflecting on poverty as a deprivation of basic capabilities rather than merely lowness of income (Sen, 1983). UN has a consistent view and define poverty from a human right perspective as “a human condition characterized by the sustained or chronic deprivation of the resources, capabilities, choices, security and power necessary for the enjoyment of an adequate standard of living and other civil, cultural, economic, political and social rights” (UN, 2001).

Poverty has various manifestations. According to the programme of action of the World Summit for Social Development (UN, 1995), these manifestations include:

- lack of income and productive resources sufficient to ensure sustainable livelihoods
- hunger and malnutrition
- ill health
- limited or lack of access to education and other basic services
- increased morbidity and mortality from illness
- homelessness and inadequate housing
- unsafe environments
- social discrimination and exclusion
- lack of participation in decision-making and in civil, social and cultural life

This list clearly demonstrates the complex nature of poverty and the intimate connection with health and with factors that influence health.

Health is, according to the Alma-Ata declaration, considered a human right, a vital social goal and a crucial imperative to economic development (WHO, 1978). These justifications for devoting resources to health have expanded our understanding of the nature of health and its importance to the modern world (Bloom & Canning, 2003). The WHO Commission on Macroeconomics and Health (CMH) renewed and expanded the comprehension of how investments in health can accelerate economic growth and contribute to poverty reduction and welfare gains amongst the poor (WHO, 2001):

“Improving the health and longevity of the poor is an end in itself, a fundamental goal of economic development. But it is also a *means* to achieving the other development goals relating to poverty reduction. The linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than generally understood. The burden of disease in some low-income regions, especially Sub-Saharan Africa, stands as a stark barrier to economic growth and therefore must be addressed frontally and centrally in any comprehensive development strategy.”

How can one address health as a dimension of poverty from a public health perspective? Health status is determined by socio-economic, cultural and

environmental factors that interact in a complex way with individual behaviour and genetic characteristics (Lindstrand, Bergström, Stenson, Tylleskär & Rosling, 2005). Achieving full health potential for all people requires collaboration of many actors at different levels - nations, communities, families and individuals are interdependent. The goals of public health are indeed to focus on the determinants of health, build strategic alliances and implement comprehensive programmes to promote health.

Public health has been defined as “the science and art of preventing disease, prolonging life and promoting health and efficiency through organised community efforts to ensure to every individual in the community a standard of living adequate for the maintenance of health” (Winslow, 1920). This classical definition is not outdated and success in performance relies on basic principles experienced through historical public health events (Ashton & Lee, 1998):

- recognise situations that have the potential to injure the health of the population
- identify the groups in the population that are most at risk
- formulate interventions that have the capability for achieving the objectives that are required to secure reductions in disease incidence and prevalence
- implement (or facilitate the implementation of) these interventions to an extent that make a significant enough impact

This study applies these principles and suggests moving from theory to practice by judging health in terms of outcomes. By focusing on social and economic impacts of infectious diseases, we address health both as a dimension of poverty and in terms of outcomes. Several authors support the need to apply approaches dictated by end users and results rather than focusing on input measures (Bloom & Canning, 2003). This point of departure combined with the complex and interlaced nature of ill health and poverty, requires an interdisciplinary approach, a common theoretical framework, and appropriate methods to analyse the impacts of infectious diseases on poverty (Article). Furthermore, in order to conduct comprehensive assessments, the complexity of the problem implies a broad understanding of society structure, of livelihood strategies, and of how infectious diseases may affect household welfare.

Several models are designed to capture these complex linkages in a theoretically consistent manner so that the results of the analyses can be applied empirically to illuminate the consequences of ill health on poverty (Article). These methods combine micro-economic theory and health sciences to analyse impacts of disease on household welfare indicators, but are apparently not implemented at large scale (Article).

A growing body of review papers emphasizes the need for standardized methods to analyse social and economic impacts of ill health at household level (Booyesen & Arntz, 2003; Chima, Goodman & Mills, 2003; McIntyre, Thiede, Dahlgren & Whitehead, 2006; Russell, 2004). This thesis assesses the need for methodological consensus based on an interdisciplinary research approach in order to scale up research to expand our knowledge on impacts of infectious diseases on poverty. Furthermore, the thesis assesses how the acquired knowledge may contribute to break the vicious cycle of ill health and poverty by providing foundations for actions. By collecting and comparing

empirical evidence from studies applying standardized methods to analyse impacts of infectious diseases on household welfare, it will be possible more efficiently to generate knowledge required to design and evaluate specific interventions to ensure sustainable health improvements and reduce poverty.

Background

The first International Conference on Primary Health Care in Alma-Ata in 1978 was an event of major historical significance. WHO and UNICEF convened the meeting where representatives from 134 countries, 67 international organizations and many non-governmental organizations made an epochal declaration calling for “Health for all by the year 2000” (WHO, 1978). The first article of the declaration incorporates the classical WHO definition of health and specifies the concept of health in society:

“The Conference strongly reaffirms that health, which is a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector.”

Furthermore, the declaration outlines the role of health in development by emphasising that “the promotion and protection of the health of the people is essential to sustained economic and social development”. The fifth article states that by year 2000 all people should enjoy “a level of health that will permit them to lead a socially and economically productive life”. The conference sets out an ambitious and worthy goal, requiring substantial social and political will and a united call for action.

Today, more than a quarter century later, the goal of “Health for all” has clearly not been achieved. Although there have been significant health improvements in many countries, still millions of people suffer and die every year of diseases that are preventable or treatable with existing technologies (WHO, 2005). In addition to the direct suffer and discomfort, the economic and social costs associated with infectious diseases may have a devastating influence on people’s economies and welfare (Bachmann & Booyesen, 2003; Sachs & Malaney, 2002). A high burden of malaria, tuberculosis and HIV infections, dominating diseases in many low-income countries, increases vulnerability and thereby contribute to both national and individual poverty (Bates, Fenton, Gruber, Laloo, Lara, Squire et al. 2004a). Poor peoples inability to cope with costs related to diagnosis and treatment of disease, is reported as a barrier to seek medical care (Kamolratanakul, Sawert, Kongsin, Lertmaharit, Sriwongsa, Na-Songkhla et al. 1999). There are wide gaps in health status and standard of living both within and between countries and the gaps are increasing (Hall & Taylor, 2003). Estimates from the World Bank show that 84 % of the world population live in developing countries and carry 93 % of the worldwide burden of disease, but their part of global income is only 18 % and of global health spending merely 11 % (Schieber & Maeda, 1999).

Health, as a part of the human capital, is essential to ensure peoples capability of living an economically productive life. However, ill health and poverty reinforce each other in a downward spiral undermining development (Wagstaff, 2002). The main asset of poor

people is their body, and ill health therefore imposes a high level of risk on their livelihood. It has been shown that poor people are more likely to fall ill and less likely to get medical care (Asfaw, 2003). CMH found that the economic impact of ill health on individuals and societies is far greater than previous estimates (WHO, 2001), confirming health as a key dimension of poverty (Dodd & Hinshelwood, 2004). There is also increasing empirical evidence of a “medical poverty trap” related to households being impoverished due to escalating out-of-pocket medical treatment costs, especially in combination with loss of income due to incapacity to work (McIntyre et al., 2006; Russell, 2004; Whitehead, Dahlgren & Evans, 2001).

UN acknowledges the unfair imbalance and calls for a dramatic reduction in poverty and marked improvements in the health status of the poor through the Millennium Developments Goals (MDG) initiative (UN, 2000);

MILLENNIUM DEVELOPMENT GOALS	
GOAL 1	ERADICATE EXTREME POVERTY AND HUNGER
GOAL 2	ACHIEVE UNIVERSAL PRIMARY EDUCATION
GOAL 3	PROMOTE GENDER EQUALITY AND EMPOWER WOMEN
GOAL 4	REDUCE CHILD MORTALITY
GOAL 5	IMPROVE MATERNAL HEALTH
GOAL 6	COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES
GOAL 7	ENSURE ENVIRONMENTAL SUSTAINABILITY
GOAL 8	DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT

The goals have been criticized for lack of ambition, inadequacies and shortcomings compared to the Alma-Ata declaration (Ceukelaire, 2005), but the initiative in general and the emphasis on health determinants in particular, is important and necessary for progression. The MDG may serve as a moral driving force that requires long time commitment and engagement. The renewed attention to the links between health and poverty and between health and economic development is promising.

The CMH report contributed to turn around the traditional view that economic growth is a precondition for real improvements in health by stating that “proper long-term investments to improve the health of the poor is a powerful engine for economic growth” (WHO, 2001). CMH summarized their analysis of the links between health and economic development by claiming that “just a few health conditions are responsible for a high proportion of the avoidable deaths in the poor countries and that well-targeted measures, using existing technologies, could save the lives of around 8 million people per year and generate yearly economic benefits of more than \$360 billion by 2015–2020 “.

The challenge now is to move from theory to practice, get operational and achieve real improvements in health and sustainable development in low-income countries.

Objective

The general aim of this thesis is to assess the need for a standardized interdisciplinary research approach to analyse the impacts of infectious diseases on household poverty in low-income country settings. Such impact assessments provide essential knowledge to guide formulation of interventions on the one hand, and help monitor and evaluate implemented interventions on the other hand. Evaluations in turn, may judge the efficiency of interventions in terms of their ability to achieve health improvements and reductions in household poverty with a minimum waste of time and resources.

The specific objective (Article) is to explore the research literature for empirical evidence on impacts of infectious diseases on poor rural household's economy in Sub-Saharan Africa (SSA) in terms of their ability to utilise their resources and generate income. The focus is directed to household behaviour related to time allocation and labour use, cash allocation, production responses, and other coping responses e.g. selling assets, livestock or land, borrowing and using preventative measures. Such responses serve to cope with and minimise the negative consequences of ill health on household production and consumption. Taken together, these four types of effects or responses give a good basis for assessing welfare implications of infectious diseases at household level.

Conceptual framework

Let us turn to the developing countries where we find the heaviest burden of disease and poverty. Poor people tend to be more vulnerable to health risks and to have limited access to safety nets, services and markets that may prevent disease or reduce the consequences of ill health (Ezzati, Lopez, Rodgers, Vander & Murray, 2002). Inequality and markets failures lead to heterogeneous impacts of health shocks with a gradient in disfavour of the poorest (Cohen, 1998; Donovan, Mpyisi, Bailey & Weber, 2003; Ettling, McFarland, Schultz & Chitsulo, 1994; Fabricant, Kamara & Mills, 1999; Gallup & Sachs, 2001). Type, severity and duration of illness, the role and function of the patient in the household, and seasonality in transmission are factors that affect coping strategies and outcomes and therefore need consideration in the impact analyses (Russell, 2004; Sauerborn, Nougara, Hien & Diesfeld, 1996).

Furthermore, in most developing countries, agriculture remains the primary source of income for the majority of the population. Agricultural households are the main form of economic organization characterized by complex behavioural patterns (Singh, Squire & Strauss, 1986). These households produce partly for sale and partly for own consumption, purchase some of their inputs and provide some, like family labour, from their own resources. They act as combined production and consumption units. Sale and purchase depend on operative and efficient markets, but in these rural areas infrastructure is limited and markets, also for labour and credit, tend to function poorly (Holden, Shiferaw & Pender, 2004). A fundamental consequence of these market imperfections is that household decisions regarding production and consumption become non-separable, implying that health shocks and poverty will affect production decisions and consequently household income (Dercon & Hoddinott, 2005). This intimate connection combined with the variation in household characteristics, and their vulnerability and responses to ill health, complicates the impact analyses considerably.

Drawing on microeconomic theory and basic agricultural household models (Becker, 1965; Singh et al., 1986) researchers have developed dynamic models adapted to low-income country settings in order to perform a more complete impact assessment analysis at household level. Such models expand from basic models in various ways by explicitly incorporate variables like market imperfections and risks (Janvry & Sadoulet, 2006), and variables on health status and functional capacity (Berman, Kendall & Bhattacharyya, 1994; Pitt, Rosenzweig & Hassan, 1990; Popkin, 1982; Rosenfield, Golladay & Davidson, 1984; Russell, 2005; Sauerborn, Ibrango, Nougara, Borchert, Hien, Benzler et al. 1995). Implementation of numerous measurable attributes of health, family time allocation and labour use, agricultural seasonality and production, functionality of different markets, investments, risks and coping strategies demonstrate the complexity of the models and the need for comprehensive data collection and interdisciplinary collaboration. This approach represents a theoretical framework adequate to provide a basis for understanding the behavioural implications and social and economic performance of households affected by infectious diseases.

The conceptual model developed for the review (Article), is shown in the Figure 1. The figure illustrates the agricultural livelihood cycle of input and investment to generate output and income for consumption and further investments. Health shocks, defined as random negative health impacts, may disturb the cycle in different ways and change household behaviour. These changes can be measured by collecting data on time allocation and labour capacity of all household members, on input and output variables in production, on cash allocation, and on other coping responses effectuated to minimise effects of health shocks. En bloc, quantification of these responses and effects of illness give a good foundation for assessing impacts of infectious diseases on household welfare and livelihood.

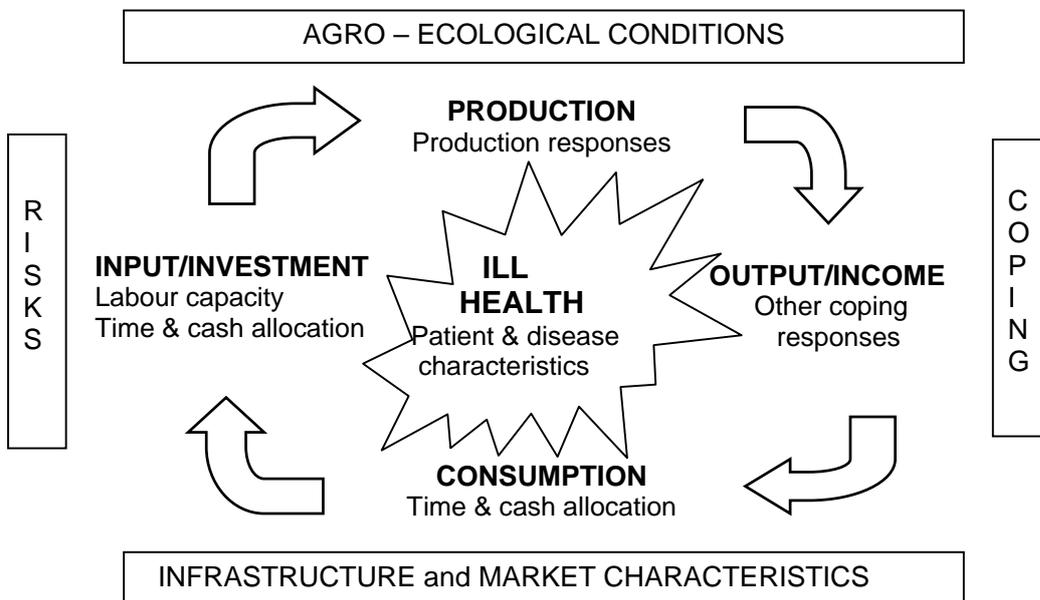


Figure 1. Simple illustration of conceptual model for rural households.

Materials and Methods

Guided by the conceptual framework, a comprehensive and systematic literature review was conducted (Article). The aim was to provide empirical evidence on impacts of infectious diseases on rural households' economy in SSA. Primary research studies assessing impacts at household level concerning effects on time allocation and labour use, cash allocation, production responses, and/or other coping responses were selected for the review (Table 1).

Table 1. Studies included in the review.

Authors, year	Country	Infectious disease studied
Amacher et al., 2004; Ersado, 2005; Ersado et al., 2004 *	Ethiopia	Malaria and schistosomiasis
Asenso-Okyere & Dzator, 1997	Ghana	Malaria
Audibert et al., 2003	Cote d'Ivoire	Malaria
Audibert, 1986	Cameroon	Malaria and schistosomiasis
Cropper et al., 2004	Ethiopia	Malaria
Ettling et al., 1994	Malawi	Malaria
Girardin et al., 2004	Côte d'Ivoire	Malaria
Ngalula et al., 2002	Tanzania	AIDS
Nur, 1993	Sudan	Malaria
Onwujekwe et al., 2000	Nigeria	Malaria
Sauerborn et al., 1995	Burkina Faso	Diarrhoea, lower respiratory infections, malaria and schistosomiasis
Sauerborn et al., 1991	Burkina Faso	Malaria
Tibaijuka, 1997	Tanzania	AIDS
Wang'Ombe & Mwabu, 1993	Kenya	Malaria
Yamano & Jayne, 2004	Kenya	AIDS

* Partly overlapping papers based on the same dataset referred to as one study

African countries south of Sahara were chosen as study area because most of these countries are major targets for the MDG initiative and many are main beneficiaries of Nordic development assistance. SSA is the region of the world carrying the heaviest burdens of disease and poverty illustrated by the fact that 44 % of the population lives below the poverty line of 1\$ a day (World Bank, 2005) and the number is increasing. Furthermore, we concentrate on studies conducted in rural areas where two thirds of the population lives and poverty levels are often double those in urban areas (ibid).

The household was the preferred unit of analysis because, in the target population, households rather than individuals make decisions to allocate resources in response to illness (Berman et al., 1994; Sauerborn et al., 1995). A household is, according to a functional classification, defined as a residence group – commonly linked together with kinship ties - that carries out domestic functions (Bender, 1967). Households in rural SSA operate as combined production and consumption units. Therefore, illness in one or several household members may influence production as well as consumption and welfare of the household. Furthermore, the responsibility for care and support weigh heavily on poor households, as government health spending tends to favour the better offs (Castro-Leal, Dayton, Demery & Mehra, 2000).

Ill health was in this setting limited to the communicable diseases that dominate the burden of disease among populations in SSA (WHO, 2005). These conditions, i.e. diarrhoeal diseases, HIV/AIDS, lower respiratory infections, malaria, schistosomiasis and tuberculosis reflects on different aspects of low standards of living – they are mainly the diseases of the poor. Existing knowledge and medicine that prevent and cure these illnesses are typically out of reach for the poorest.

Studies were identified using electronic databases, mainly PubMed, Science Direct, ISI Web of Knowledge, JSTOR and Google Scholar using a range of keywords relating to impacts of infectious diseases. Terms like “impact”, “economic impact”, “cost of illness”, “burden of illness” were used in combination with “infectious disease”, “communicable disease” or name of included diseases like “malaria” and “AIDS”. Key websites from the World Bank, WHO and UN, and other internet sites likely to provide relevant information were consulted in addition to experienced colleagues. Furthermore, a secondary search of the bibliographies of relevant studies was carried out. The literature survey was challenging due to the multi- and interdisciplinary nature of my research questions. Limited tradition of cooperation between different disciplines was reflected in the lack of standardized keywords and publication routines.

The literature search revealed 212 papers written in English that were considered for the review. Studies were included if they quantified impacts of the specified infectious diseases on household time and/or cash allocation and labour use (e.g. work time lost due to illness and caretaking, labour substitution and illness related expenditures) and/or production responses and other coping responses (e.g. changes in agricultural area, output and type of crop, preventative measures and selling of assets or land). A total of 15 studies (17 papers) met the inclusion criteria (Table 1).

Papers were excluded if they were theoretical papers, reports or reviews without primary research data (90), did not quantify impacts on the specified effects and responses at household level (44), assessed impacts of illness in general without specifying any disease or assessed other diseases than the ones selected in this review (30), or were conducted outside SSA (21) or in urban areas (7).

Results

Fifteen studies, conducted in ten different countries, satisfied the inclusion criteria and were included in the review (Table 1). The studies are in the Article presented in a tabular form with information on country of origin, study design and measured impacts of infectious diseases classified per effect and response type and per disease. We compared impacts on time allocation and labour use, cash allocation, production responses, and other coping responses for malaria, AIDS and combinations of infectious diseases respectively (Table 2). No studies that assessed the impacts of tuberculosis in rural SSA were found.

Table 2. Studies classified per disease and per effect and response type studied.

Disease studied	Total number of studies	Time allocation and labour use	Cash allocation	Production responses	Other coping responses
Malaria	9	7	7	3	4
AIDS	3	2	3	2	3
Combination of diseases	3	2	2	2	0

The majority of the studies applied a cross-sectional study design covering a smaller geographical region. Two studies applied a longitudinal study design and two surveys had a national coverage.

The review revealed a large diversity in units of analysis and definition of variables. For example, estimates of out-of-pocket expenditures due to illness might include drugs and various treatment costs, fees at clinics, transportation, food and lodging for patient and/or caretaker. Due to lack of standardization, definition of such direct costs varied from survey to survey, generally accompanied of insufficient reporting. Likewise, estimates of work time lost were reported for patients only or for patients and caretakers separately or combined, stratified or not on age, gender and severity of illness and reported either per case, or per two weeks, per one, six or ten months, per cropping season or per year with recall periods varying from two weeks to two years. For malaria, five studies estimated the monetary value of work time lost using five different approaches.

The diversity in methodological design made comparison of results and deducing general conclusions extremely limited.

Discussion

The fight against infectious diseases and poverty is highly prioritized on the world development agenda. One might expect that global commitments and targets would give rise to substantial research investments due to the complexity of the linkages between infectious diseases and poverty and their variation across diseases and households in different community settings. This complexity calls for multi- and interdisciplinary research approaches and comprehensive analytical tools in order to provide adequate evidence-based knowledge (Berman et al., 1994; Danziger, 1994; Mesko, Wieggers & Hermanrud, 2003). However, our critical review of the literature assessing impacts of infectious diseases on rural household welfare in SSA revealed a scarcity of relevant studies and diversity in methodological design, obstructing comparison of results and extraction of reliable conclusions (Article).

These discouraging findings are somehow surprising given important stakeholders' increased focus on health and poverty culminating with the MDG. Several other reviews report similar methodological findings when addressing consequences of infectious diseases at household level in low-income countries worldwide (Booyesen & Arntz, 2003; Chima et al., 2003; McIntyre et al., 2006; Russell, 2004). In the Article, we address the methodological problems and the lack of relevant surveys by pointing at major obstacles and suggest ways to overcome them to be able to scale up research. Furthermore, we discuss the necessity of extended and more coordinated research to fill important knowledge gaps to reduce more efficiently the prevalence of communicable diseases directly and poverty indirectly. We conclude that a key factor to achieve these goals is to reach methodological standardisation and consensus based on multi- and interdisciplinary collaboration at an international level.

The aim of the review (Article) was to provide empirical evidence of the consequences of infectious diseases in terms of household time allocation and labour use, cash allocation, production responses and other coping responses. This empirical information has the potential to identify population groups most at risk, describe their burden of disease, classify types and severity of consequences of ill health, and display the extent and nature of causal relationships running from infectious diseases to poverty. Such research-based knowledge is essential to understand the scale and nature of the problems.

Yet, the rationale for the research is that the acquired knowledge provides foundation for formulation of efficient interventions in order to alleviate or eliminate causes and effects of infectious diseases at household level. The logical implication follows that if ill health leads to poverty then non-occurrence of ill health has the potential to stimulate economic growth and reduce poverty. Hence, the natural next step and way forward is to convert the acquired knowledge into efficient interventions. Since these interventions may include promoting or protecting health, preventing or curing disease or supporting household safety nets, an expansion of the chain of reactions running from infectious diseases to poverty is necessary to include causes and determinants of the diseases. Potential feasible targets for interventions aimed at the chain are illustrated in the figure below (Figure 2).

The figure demonstrates in a simple way the series of events from the underlying causes of communicable diseases via ill health causing household responses to measurable effects on household welfare. Furthermore, the figure shows how interventions may be directed in principally four different ways:

- to attack the underlying causes of the health problem
- to block or protect against the causes of ill health
- to cure ill health
- to provide safety nets for those affected by ill health

It is far from obvious which types of interventions are more efficient in reducing ill health directly and poverty indirectly in a given setting. Maybe a combination of interventions is more efficient than using a single type of intervention. It is possible that the efficiency of one type of intervention is highly dependent on other types of interventions, or highly sensitive to various environmental characteristics. Even though cost-effective interventions exist that could substantially improve global health, knowledge about which delivery strategies could and should be implemented to achieve high population coverage is scarce (Mexico, 2004). However, it is likely that optimal intervention strategies will vary from one type of health problem to another, as well as depend on household and community characteristics.

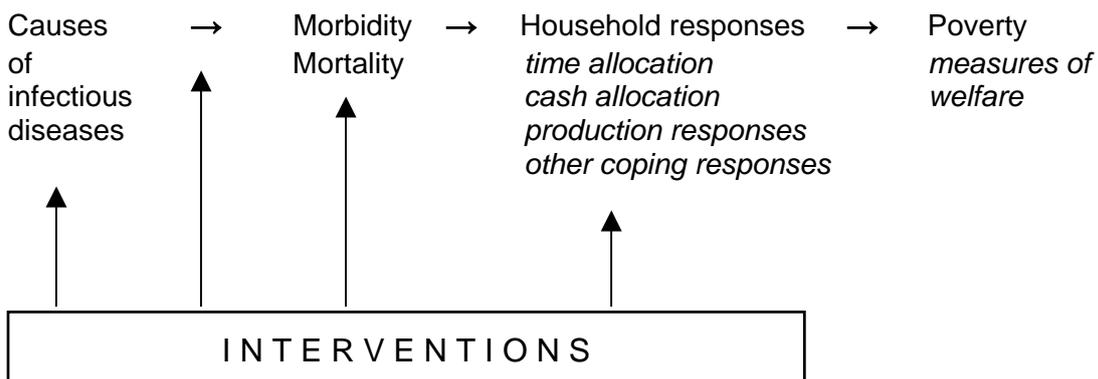


Figure 2. Alternative intervention targets affecting the chain of reactions running from determinants of infectious diseases to poverty.

Malaria and HIV/AIDS are well suited to illustrate the diversity, as they represent two fundamentally different types of health problems that may induce different types of interventions. They also represent two of the major diseases of the poor and cause huge problems in low-income countries (Bates et al., 2004a; Bates, Fenton, Gruber, Lalloo, Lara, Squire et al. 2004b). While malaria is caused by the protozoan *Plasmodium* transmitted by mosquito-bites, AIDS develops after transmission of virus-infected human body fluids from person to person. These different transmission routes imply that malaria interventions may be directed to attack the underlying cause directly by vector and habitat control e.g. by using insecticides and avoid stagnant water that act as breeding places for mosquitoes or by protecting the population from being bitten e.g. by improving housing conditions and by using bed nets. Preventing transmission of HIV, on the other hand, requires interventions aimed mainly at human behaviour, as

sexual activity remains the major route of transmission. Use of condoms may here serve a similar role like mosquito bed nets, but it is not possible, by methods known today, to eradicate the HIV virus.

Once infected, malaria patients can be cured by existing drugs although drug resistance is increasing, while for the HIV infected persons, medicines can only delay onset of the life-threatening diagnosis of AIDS. Furthermore, the availability and affordability of drugs especially and health care services generally, vary considerably with the lowest coverage among poor people in rural areas. At best, only one person out of ten in Africa and one in seven in Asia in need of antiretroviral HIV treatment were receiving it in mid-2005 (UNAIDS/WHO, 2005).

The impact on the households also varies considerably due to the severity and duration of illness. Clinical malaria attacks occur generally after one to two weeks incubation period and cause one to 21 work days lost per episode for adults (Chima et al., 2003). Progress to severe malaria and death occur in about three percent of the cases, mainly among children and pregnant women (Najera & Hempel, 1996). The situation is quite different for HIV/AIDS. The incubation time from a HIV infection to the AIDS diagnose ranges from about two months to 20 years or longer, median ten years, (IDEAS, 2004) and the infected person may be unaware of both the infection and the transmission potential. This has implications both for diagnostics and for preventing further transmission. Stigma and prejudice related to HIV/AIDS complicates further and requires special attention. AIDS usually induce several months of care-demanding illness before death occurs causing a severe burden on the families and relatives of the AIDS patient (Ngalula et al., 2002; Tibaijuka, 1997). Since the disease mainly takes the lives of adolescents and adults and make children orphaned, this impoverishes the households beyond the capacity of their traditional safety nets and thus lead to family collapses and destitute orphans.

Estimated 40 million people were living with HIV globally in 2005 and so far the AIDS epidemic has killed more than 25 million people since it was first recognized in 1981 (UNAIDS/WHO, 2005). Clinical malaria episodes, on the other hand, occur up to 500 million times annually, causing more than one million deaths each year (WHO/UNICEF, 2005). These figures demonstrate the tremendous magnitude of the problem. This high burden of malaria and HIV/AIDS has, in addition to the direct illness suffering and grief, devastating social and economic consequences for the households due to medical treatment and related financial costs, productive time losses resulting from illness and subsequent household responses and coping strategies. There is growing evidence of households being pushed into poverty or forced into deeper poverty when faced with these economic impacts (McIntyre et al., 2006).

This brief overview shows that consequences of infectious diseases on households are multifaceted and complex; they vary in type and severity depending on households' vulnerability (Dercon & Hoddinott, 2005), and thereby imply different needs regarding interventions. How should one assess these intervention options against each other? Should one invest more in promoting health and preventing transmission of disease than in curing illness or supporting safety nets? Which types of interventions or combinations of interventions are most successful regarding reaching the poor and reducing their poverty? The revolution of "evidence-based" practice has also reached the area of public health, implying that decisions should be based on best current, relevant, and reliable knowledge (Kamper-Jørgensen, 2000).

The saying “In God we trust; all others bring data” is not only trendy, but emphasizes the importance of sound research-based knowledge as a cornerstone to guide decision-making processes. Knowledge-production in the field of public health should be comprehensive and include knowledge from four different domains; distribution of health, determinants or causal web, consequences, and intervention methods (Eriksson, 2000). Several authors discuss and support the demand for evidence-based knowledge to intervene more efficiently given the scarcity of resources (DFID, 2000; Goudge & Govender, 2000; Holland, Fisher, James & Walford, 2000; Russell, 2005).

Since resources are limited, there will be trade-offs between alternative interventions. Trade-offs require evaluation and prioritizing processes, which in turn should rely on empirical evidence. Such empirical knowledge accumulates through extended, systematic and well-targeted research based on methodological consensus (Article). A recent review assessing the state of the art of evaluation of malaria interventions in Africa, reported discouraging findings (Eisele, Macintyre, Eckert, Beier & Killeen, 2000):

- methodological shortcomings and lack of standardization limited the usefulness of existing studies
- between-study comparison was extremely limited due to methodological shortcomings
- there was a paucity of studies on possible synergistic effects of combining intervention types
- due to spatial and seasonal variations in malaria transmission, generalizability of results was very difficult

The authors advocate the need of more systematic evaluation protocols using standardized indicators in a wide variety of locations to assist implementation of effective large-scale interventions to control malaria. WHO recognised the gap of knowledge and convened a task force to suggest areas where international collaborative research could help to generate the knowledge necessary to overcome health systems constraints that impede implementation of major global initiatives for health (Task Force on Health Systems Research, 2004). Suggested topics for the task force encompass organisation and delivery of health services, financial and human resources, and knowledge management. The knowledge gaps hamper sound decisions regarding choosing interventions consistent with the epidemiological profile of the population and planning for effective, large-scale and context-specific delivery mechanisms (Victora, Hanson, Bryce & Vaughan, 2004). Constraints to reach poor populations with public health interventions go well beyond availability of sufficient funds. Resources need to be invested to bring forth knowledge to support the process by which academic knowledge can be applied in real life (Mexico, 2004).

I argue that experimental studies should be an essential part of this knowledge accumulation. Experimental intervention studies imply small-scale studies designed to test hypothesized cause-effect relationships in the study population and evaluating outcomes before implementing large-scale interventions. The intention is to improve quality and efficiency of interventions and avoid waste of time and resources. Furthermore, experimental design implies a randomization process that randomly assigns individuals or households to an intervention group or a control group. The purpose of such randomization is to ensure that the groups differ only with respect to the intervention being compared. Such randomized controlled trials improve quality and

validity of surveys by controlling for counterfactual variables, and thereby reduce the possibility for systematic errors.

In order to monitor and evaluate interventions aimed at poverty reductions through health improvements, the analytical tools must embrace all elements in the chain of reactions from causes of infectious diseases to poverty that are incorporated in the intervention (Figure 2). This implies collection of all relevant data starting from the target of the intervention to the end element of poverty measures. Such data collection allows difference-in-difference estimation by comparison of study objects in intervention group and control group before and after implementation of interventions. The study design should enable the researcher to analyze to what extent the implemented intervention has direct or indirect effects on health and poverty. To illustrate this point I will provide some examples.

An experimental approach may be useful to investigate determinants of purchase of protective malaria measures like insecticide-treated mosquito nets (ITN) and to explore the policy implications of the findings for ITN programmes. In many developing countries, people are expected to contribute to the cost of health care from their own pockets. As a result, people's ability or willingness to pay (WTP) for health care has become a critical policy issue (Russell, 1996). Results from a study conducted in Nigeria showed how stated WTP was a good predictor for actual net purchases and how obstacles like time and travel costs for households lead to lower ITN coverage especially for poorer socioeconomic groups and those at greater risk of malaria infections (Onwujekwe, Hanson & Fox-Rushby, 2003). The paper points at specific requirements related to ITN coverage and inequalities regarding beneficiaries of the programme. Such experiences give opportunities for adjustments before implementation at larger scale to enhance intended programme effects, e.g. to achieve higher net coverage amongst the poorest.

Another experimental study is published in a paper comparing social and unassisted commercial marketing techniques to stimulate markets for ITN in Tanzania (Kikumbih, Hanson, Mills, Mponda & Schellenberg, 2005). Social marketing seeks to influence social behaviour by applying tools and concepts of commercial marketing to "sell" ideas, attitudes and behaviours to benefit the target audience and the general society. The study revealed that social marketing increased both demand and supply of ITN leading to a higher overall coverage rate together with higher coverage of the poorest socioeconomic group, despite higher cost per net distributed. The study demonstrates the value of assessing impacts by measuring coverage in disaggregated population groups rather than crude measures such as sales volume to monitor to which degree the health intervention is adopted in the population.

However, these two experimental studies share common limitations in survey design regarding the ability to predict poverty reduction potential of increased coverage of protective malaria measures. The limitations entail lack of information about possible health gains and effects on household welfare and thereby miss the opportunity to apply a more comprehensive approach to deal with the complex relationships between infectious diseases and poverty. These studies are representative for a large body of intervention studies that fail to address the poverty implications, implying a scarcity of studies assessing interventions aimed at poverty reduction through health improvements. One explanation may be that assessing poverty reduction potential requires longitudinal data collection and this type of study design is not applied at large

scale in this field of research (Article). Another explanation is that the limited tradition of multi- and interdisciplinary research collaboration hampers more comprehensive analyses of the linkages between infectious diseases and poverty (Pattanayak, Dickinson, Corey, Murray, Sills & Kramer, 2006).

Another important aspect to consider is the opportunity to draw general conclusions from studies and to transfer experiences from one study population and setting to another. Such validations assume a certain degree of homogeneity in households and settings in order to predict outcomes in new settings based on empirical surveys conducted in other settings. Application of spatial analytic tools like Geographic Information Systems (GIS) has proved useful in this respect as these tools are concerned with describing, quantifying, and explaining geographical variations in specified variables (Rushton, 2003). The development of a more structured and organized system of geo-referenced data opens new ways of linking health data to potential sources of environmental exposure and geodemographic characteristics of populations (Nuckols, Ward & Jarup, 2004). Such databases require input from several scientific disciplines like geospatial science, environmental science, social sciences, and epidemiology and thereby represent valuable tools for multi- and interdisciplinary collaboration and research. Advances in GIS and statistical methodology together with availability of adequate data collection and databases represent new opportunities to investigate the environmental, social, and behavioural factors underlying geographical variations in disease rates.

GIS is being used with increasing frequency in public health research as demonstrated by the following application examples. An ecosystem approach was applied in a study of rural communities in the Amazon region to provide a holistic view of the socioeconomic and ecological factors affecting health and obtain insight into causal linkages between health, biodiversity and natural resource use (Murray & Sanchez-Choy, 2001). A similar approach was applied to study how changes in a tribal group ecosystem in India due to human activities, development and modernization affected and threatened population health and livelihood (Reddy, 2004).

Multi- and interdisciplinary research collaboration brings in new perspectives and expands our knowledge in ways that may enhance the attainment of the Millennium Development Goals. For instance, improvement in health is a goal in itself, justified traditionally by advocating health as a basic human right and a vital social goal. However, by demonstrating beyond these goals, by applying multi- and interdisciplinary approaches, the potential of health as a means to reduce poverty and contribute to economic growth, one enhances the justification to invest in poor people's health.

Economic development in low-income countries will increase the opportunities for richer countries to profit from investments in the developing world. Applying a strategy that emphasizes shared benefits for donor and recipient, like mutually economic benefits, will facilitate health and poverty reduction programs (Folch, Hernandez, Barragan & Franco-Paredes, 2003). The creation of a win-win situation is also the main message of the Commission on Macroeconomics and Health when concluding on their analyses of investments in health (WHO, 2001). The Commission claims that proper long-term investments to improve the health of the poor have the potential to gain substantial economic benefits. The renewed attention on the relationship between health and economic development challenge stakeholders to move from theory to practice and intervene.

Conclusion

This thesis presents the findings of a critical review of studies assessing impacts of major infectious diseases on household poverty in rural Sub-Saharan Africa. The review revealed a scarcity of relevant studies at national level, insufficient methodological quality in short-term geographically limited studies, and extensive heterogeneity in study design, making comparison of results very difficult or impossible.

The complex linkages between infectious diseases and poverty and their variation across diseases and households in different community settings imply methodological challenges when assessing impacts of ill health on household economy. This thesis argues that methodological standardisation and consensus will enable us to scale up research and acquire adequate evidence-based knowledge to guide formulation of efficient interventions and to monitor and evaluate implemented interventions. Knowledge acquisition should include experimental intervention studies to improve quality and efficiency of interventions and avoid waste of time and resources. Methodological consensus should rely on multi- and interdisciplinary collaboration at national and international level to be able to deal with the complexity of infectious diseases and poverty in a more expansive and comprehensive manner. The development of more structured and organized databases give opportunities of linking data in innovative ways to provide new insights and perspectives.

Extensive knowledge gaps hamper formulation, implementation and evaluation of interventions. By investing resources in achieving consensus on adequate research methods and analytic tools, we will increase the likelihood of doing the right things in a right way. This thesis is not the first to address the problem, but may contribute towards scaling-up of adequate research in order to bring the Millennium Development Goals closer to achievement.

"Not until the creation and maintenance of decent conditions of life for all people are recognized and accepted as a common obligation of all people and all countries - not until then shall we, with a certain degree of justification, be able to speak of humankind as civilized."

Albert Einstein, 1945

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References

Amacher,G., Ersado,L., Hyde,W., & Osorio,A. (2004). Tree planting in Tigray, Ethiopia: the importance of human disease and water microdams. *Agroforestry Systems*, 60(3), 211-225.

Asenso-Okyere,W.K., & Dzator,J.A. (1997). Household cost of seeking malaria care, a retrospective study of two districts in Ghana. *Social Science & Medicine*, 45(5), 659-667.

Asfaw,A. (2003). How Poverty affects Health Status and Health Care Demand Behaviour of Households – The Case of Rural Ethiopia.Conference Proceedings: Staying Poor - Chronic Poverty and Development Policy, Manchester 7 - 9 April 2003.

Ashton,J., & Lee,B. (1998). Being prepared to protect the public health. Information for thinking the unthinkable and doing the essential. *Journal of Epidemiology & Community Health*, 52(11), 702-703.

Audibert,M. (1986). Agricultural non-wage production and health status - A case study in a tropical environment. *Journal of Development Economics*, 24(2), 275-291.

Audibert,M., Mathonnat,J., & Henry,M.C. (2003). Social and health determinants of the efficiency of cotton farmers in Northern Cote d'Ivoire. *Social Science & Medicine*, 56(8), 1705-1717.

Bachmann,M.O., & Booyesen,F.L. (2003). Health and economic impact of HIV/AIDS on South African households: a cohort study. *BMC Public Health*, 3(1), 14.

Bates,I., Fenton,C., Gruber,J., Lalloo,D., Lara,A.M., Squire,S.B., Theobald,S., Thomson,R., & Tolhurst,R. (2004a). Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease. Part I: determinants operating at individual and household level. *Lancet Infectious Diseases*, 4(5), 267-277.

Bates,I., Fenton,C., Gruber,J., Lalloo,D., Lara,A.M., Squire,S.B., Theobald,S., Thomson,R., & Tolhurst,R. (2004b). Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease. Part II: determinants operating at environmental and institutional level. *Lancet Infectious Diseases*, 4(6), 368-375.

Becker,G.S. (1965). A Theory on the Allocation of Time. *The Economic Journal*, 75 493-517.

Bender,D.R. (1967). A Refinement of the Concept of Household: Families, Co-Residence, and Domestic Functions. *American Anthropologist*, 69(5), 493-504.

Berman,P., Kendall,C., & Bhattacharyya,K. (1994). The household production of health: Integrating social science perspectives on micro-level health determinants. *Social Science & Medicine*, 38(2), 205-215.

Bloom,D.E., & Canning,D. (2003). The Health and Poverty of Nations: from theory to practice. *Journal of Human Development*, 4(1), 47.

- Booyesen, F.L., & Arntz, T. (2003). The methodology of HIV/AIDS impact studies: a review of current practices. *Social Science & Medicine*, 56(12), 2391-2405.
- Castro-Leal, F., Dayton, J., Demery, L., & Mehra, K. (2000). Public spending on health care in Africa: do the poor benefit? *Bulletin of the World Health Organization*, 78(1), 66-74.
- Ceukelaire, W.D. (2005). Health for All or Health for Half? *Third World Resurgence*, 180/181.
- Chima, R.I., Goodman, C.A., & Mills, A. (2003). The economic impact of malaria in Africa: a critical review of the evidence. *Health Policy*, 63(1), 17-36.
- Cohen, D. (1998). Poverty and HIV/AIDS in Sub-Saharan Africa. New York: United Nations Development Programme.
- Cropper, M.L., Haile, M., Lampietti, J., Poulos, C., & Whittington, D. (2004). The demand for a malaria vaccine: evidence from Ethiopia. *Journal of Development Economics*, 75(1), 303-318.
- Danziger, R. (1994). The social impact of HIV/AIDS in developing countries. *Social Science & Medicine*, 39(7), 905-917.
- Dercon, S., & Hoddinott, J. (2005). Health, Shocks and Poverty Persistence. In S. Dercon (Ed.), *Insurance Against Poverty* Oxford: Oxford University Press.
- DFID (2000). Which health policies are pro-poor? London: Department for International Development - Health Resource Centre.
- Dodd, R., & Hinshelwood, E. (2004). Poverty Reduction Strategy Papers: Their Significance for Health - second synthesis report. Geneva: World Health Organization.
- Donovan, C., Mpyisi, E., Bailey, L., & Weber, M. (2003). Prime Age Adult Morbidity and Mortality in Rural Rwanda: Which Households Are Affected and What are Their Strategies for Adjustment? Conference Proceedings: Triennial Conference of the International Association of Agricultural Economists, Durban, August 2003.
- Eisele, T., Macintyre, K., Eckert, E., Beier, J., & Killeen, G. (2000). Evaluating Malaria Interventions in Africa: A Review and Assessment of Recent Research. Chapel Hill: MEASURE Evaluation.
- Eriksson, C. (2000). Learning and knowledge-production for public health: a review of approaches to evidence-based public health. *Scandinavian Journal of Public Health*, 28(4), 298-308.
- Ersado, L. (2005). Small-scale irrigation dams, agricultural production, and health: Theory and evidence from Ethiopia. Washington: The World Bank.
- Ersado, L., Amacher, G., & Alwang, J. (2004). Productivity and Land Enhancing Technologies in Northern Ethiopia: Health, Public Investments, and Sequential Adoption. *American Journal of Agricultural Economics*, 86(2), 321-332.

- Ettling, M., McFarland, D.A., Schultz, L.J., & Chitsulo, L. (1994). Economic impact of malaria in Malawian households. *Tropical Medicine and Parasitology*, 45(1), 74-79.
- Ezzati, M., Lopez, A.D., Rodgers, A., Vander, H.S., & Murray, C.J. (2002). Selected major risk factors and global and regional burden of disease. *Lancet*, 360(9343), 1347-1360.
- Fabricant, S.J., Kamara, C.W., & Mills, A. (1999). Why the poor pay more: Household curative expenditures in rural Sierra Leone. *International Journal of Health Planning and Management*, 14(3), 179-199.
- Folch, E.M., Hernandez, I.M., Barragan, M.M., & Franco-Paredes, C.M.M. (2003). Infectious Diseases, Non-Zero-Sum Thinking, and the Developing World. *American Journal of the Medical Sciences*, 326(2), 66-72.
- Gallup, J.L., & Sachs, J.D. (2001). The economic burden of malaria. *American Journal of Tropical Medicine and Hygiene*, 64(1-2 Suppl), 85-96.
- Girardin, O., Dao, D., Koudou, B., Esse, C., Cisse, G., Yao, T., N'Goran, E., Tschannen, A., Bordmann, G., Lehmann, B., Nsabimana, C., Keiser, J., Killeen, G., Singer, B., Tanner, M., & Utzinger, J. (2004). Opportunities and limiting factors of intensive vegetable farming in malaria endemic Cote d'Ivoire. *Acta Tropica*, 89(2), 109-123.
- Goudge, J., & Govender, V. (2000). A review of experience concerning household ability to cope with the resource demands of ill health and health care utilisation - An examination of the literature about the resource demands of ill-health. Harare: EQUINET - Regional Network on Equity in Health in Southern Africa.
- Hall, J.J., & Taylor, R. (2003). Health for all beyond 2000: the demise of the Alma-Ata Declaration and primary health care in developing countries. *The Medical Journal of Australia*, 178(1), 17-20.
- Holden, S.T., Shiferaw, B., & Pender, J. (2004). Off-farm Income, Household Welfare and Sustainable Land Management. *Food Policy*, 29 369-392.
- Holland, J., Fisher, E., James, S., & Walford, V. (2000). Becoming poverty-focused: implications for health. London: Department for International Development - Health Resource Centre.
- IDEAS (2004). Acquired immunodeficiency syndrome (AIDS). Victoria: Victorian Government Health Information - Infectious Diseases Epidemiology and Surveillance.
- Janvry, A.d., & Sadoulet, E. (2006). Progress in the Modeling of Rural Households' Behavior under Market Failures. In A.d. Janvry, & R. Kanbur (Eds.), *Poverty, Inequality and Development - Essays in Honor of Erik Thorbecke* New York: Springer.
- Kamolratanakul, P., Sawert, H., Kongsin, S., Lertmaharit, S., Sriwongsa, J., Na-Songkhla, S., Wangmane, S., Jittimane, S., & Payanandana, V. (1999). Economic impact of tuberculosis at the household level. *The international journal of tuberculosis and lung disease*, 3(7), 596-602.
- Kamper-Jørgensen, F. (2000). Knowledge-base, evidence and evaluation in Public Health. *Scandinavian Journal of Public Health*, 28(4), 241-243.

- Kikumbih,N., Hanson,K., Mills,A., Mponda,H., & Schellenberg,J.A. (2005). The economics of social marketing: the case of mosquito nets in Tanzania. *Social Science & Medicine*, 60(2), 369-381.
- Lindstrand,A., Bergström,S., Stenson,B., Tylleskär,T., & Rosling,H. (2005). Global Health: an introductory textbook. Lund: Studentlitteratur.
- McIntyre,D., Thiede,M., Dahlgren,G., & Whitehead,M. (2006). What are the economic consequences for households of illness and of paying for health care in low- and middle-income country contexts? *Social Science & Medicine*, 62(4), 858-865.
- Mesko,N., Wieggers,E., & Hermanrud,V. (2003). HIV/AIDS and Agriculture: Impacts and Responses. Case Studies from Namibia, Uganda and Zambia. (pp.1-34). Rome: Food and Agricultural Organization.
- Mexico (2004). Global health needs a new research agenda. *Lancet*, 364(9445), 1555-1556.
- Murray,T.P., & Sanchez-Choy,J. (2001). Health, biodiversity, and natural resource use on the Amazon frontier: an ecosystem approach. *Cadernos de Saude Publica*, 17 Suppl 181-191.
- Najera,J.A., & Hempel,J. (1996). The burden of malaria. Geneva: World Health Organization.
- Ngalula,J., Urassa,M., Mwaluko,G., Isingo,R., & Boerma,J.T. (2002). Health service use and household expenditure during terminal illness due to AIDS in rural Tanzania. *Tropical Medicine & International Health*, 7(10), 873-877.
- Nuckols,J.R., Ward,M.H., & Jarup,L. (2004). Using geographic information systems for exposure assessment in environmental epidemiology studies. *Environmental Health Perspectives*, 112(9), 1007-1015.
- Nur,E.T.M. (1993). The impact of malaria on labour use and efficiency in the Sudan. *Social Science & Medicine*, 37(9), 1115-1119.
- Onwujekwe,O., Hanson,K., & Fox-Rushby,J.A. (2003). Who buys insecticide-treated nets? Implications for increasing coverage in Nigeria. *Health Policy and Planning*, 18(3), 279-289.
- Onwujekwe,O., Chima,R., & Okonkwo,P. (2000). Economic burden of malaria illness on households versus that of all other illness episodes: a study in five malaria holo-endemic Nigerian communities. *Health Policy*, 54(2), 143-159.
- Pattanayak,S., Dickinson,K., Corey,C., Murray,B., Sills,E., & Kramer,R. (2006). Deforestation, malaria and poverty: a call for transdisciplinary research to support the design of cross-sectoral policies. *Science, Practice, & Policy*, 2(2), 45-56.
- Pitt,M.M., Rosenzweig,M.R., & Hassan,N. (1990). Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries. *The American Economic Review*, 80(5), 1139-1156.

- Popkin,B.M. (1982). A household framework for examining the social and economic consequences of tropical diseases. *Social Science & Medicine*, 16(5), 533-543.
- Reddy,S. (2004). Ecosystems Approach to Human Health: A Case of Konda Reddi Tribesand Women's Health. *Journal of Human Ecology*, 16(4), 271-282.
- Rosenfield,P.L., Golladay,F., & Davidson,R.K. (1984). The economics of parasitic diseases: Research priorities. *Social Science & Medicine*, 19(10), 1117-1126.
- Rushton,G. (2003). Public health, GIS, and spatial analytic tools. *Annual Review of Public Health*, 24(1), 43-56.
- Russell,S. (1996). Ability to pay for health care: Concepts and evidence. *Health Policy and Planning*, 11(3), 219-237.
- Russell,S. (2004). The economic burden of illness for households in developing countries: A review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. *The American journal of tropical medicine and hygiene*, 71(2), 147-155.
- Russell,S. (2005). Illuminating cases: understanding the economic burden of illness through case study household research. *Health Policy and Planning*, 20(5), 277-289.
- Sachs,J., & Malaney,P. (2002). The economic and social burden of malaria. *Nature*, 415(6872), 680-685.
- Sauerborn,R., Ibrango,I., Nougara,A., Borchert,M., Hien,M., Benzler,J., Koob,E., & Diesfeld,H.J. (1995). The Economic Costs of Illness for Rural Households in Burkina-Faso. *Tropical Medicine and Parasitology*, 46(1), 54-60.
- Sauerborn,R., Nougara,A., Hien,M., & Diesfeld,H.J. (1996). Seasonal variations of household costs of illness in Burkina Faso. *Social Science & Medicine*, 43(3), 281-290.
- Sauerborn,R., Shepard,D.S., Ettling,M.B., Brinkmann,U., Nougara,A., & Diesfeld,H.J. (1991). Estimating the direct and indirect economic costs of malaria in a rural district of Burkina Faso. *Tropical Medicine and Parasitology*, 42(3), 219-223.
- Schieber,G., & Maeda,A. (1999). Health care financing and delivery in developing countries. *Health Affairs*, 18(3), 193-205.
- Sen,A. (1983). Poor, Relatively Speaking. *Oxford Economic Papers, New Series*, 35(2), 153-169.
- Singh,I., Squire,L., & Strauss,J. (1986). *Agricultural Household Models. Extensions, Applications, and Policy*. Baltimore: Johns Hopkins University Press.
- Task Force on Health Systems Research (2004). Informed choices for attaining the Millennium Development Goals: towards an international cooperative agenda for health-systems research. *Lancet*, 364(9438), 997-1003.
- Tibaijuka,A.K. (1997). AIDS and economic welfare in peasant agriculture: Case studies from Kagabiro village, Kagera region, Tanzania. *World Development*, 25(6), 963-975.

- UN (1995). Report of the World Summit for Social Development . New York: United Nations.
- UN (2000). United Nations Millennium Declaration. New York: United Nations.
- UN (2001). Poverty and the International Covenant on Economic, Social and Cultural Rights. New York: United Nations.
- UNAIDS/WHO (2005). AIDS epidemic update: December 2005. Geneva: United Nations Programme on HIV/AIDS & World Health Organization.
- Victora,C.G., Hanson,K., Bryce,J., & Vaughan,J.P. (2004). Achieving universal coverage with health interventions. *Lancet*, 364(9444), 1541-1548.
- Wagstaff,A. (2002). Poverty and health sector inequalities. *Bulletin of the World Health Organization*, 80(2), 97-105.
- Wang'Ombe,J.K., & Mwabu,G.M. (1993). Agricultural land use patterns and malaria conditions in Kenya. *Social Science & Medicine*, 37(9), 1121-1130.
- Whitehead,M., Dahlgren,G., & Evans,T. (2001). Equity and health sector reforms: can low-income countries escape the medical poverty trap? *Lancet*, 358(9284), 833-836.
- WHO (1978). Declaration of Alma-Ata. Geneva: World Health Organization.
- WHO (2001). Macroeconomics and Health: Investing in Health for Economic Development - Report of the Commission on Macroeconomics and Health. Geneva: World Health Organization.
- WHO (2005). The World Health Report 2005 – Make Every Mother and Child Count. Geneva: World Health Organization.
- WHO/UNICEF (2005). The World Malaria Report 2005. Geneva: World Health Organisation & United Nations Children's Fund.
- Winslow,C.-E.A. (1920). The Untilled Fields of Public Health. *Science*, 51(1306), 23-33.
- World Bank (2005). World Development Indicators. Washington: World Bank.
- Yamano,T., & Jayne,T.S. (2004). Measuring the Impacts of Working-Age Adult Mortality on Small-Scale Farm Households in Kenya. *World Development*, 32(1), 91-119.

Appendix

Article:

Impacts of infectious diseases on poverty in Sub-Saharan Africa –
What do we know and what way forward?

Impacts of infectious diseases on poverty in Sub-Saharan Africa –

What do we know and what way forward?

Anita Blomfeldt^{1,2} & Stein Holden³

¹Institute of Clinical Epidemiology and Molecular Biology, Akershus University Hospital, University of Oslo, Nordbyhagen, Norway, ²Nordic School of Public Health, Gøteborg and ³Departement of Economics and Resource Management, Norwegian University of Life Sciences, Ås, Norway

Abstract

Information on the impacts of communicable diseases at household level is needed to target interventions efficiently and to justify investments in research and disease control. This paper presents the findings of a critical review of studies assessing the impacts of the major infectious diseases on household time allocation and labor use, household cash allocation, production responses and other coping responses in rural Sub-Saharan Africa (SSA). We found a dearth of relevant studies at national level, a poor methodological quality in many short-term geographically limited studies, and large diversity in study design making comparison of results difficult or impossible. We discuss these methodological problems and give recommendations for coordination, standardization and scaling up of data collection that allows adequate impact assessment. International collaboration and multidisciplinary approaches are essential in order to achieve a needed consensus on methodological design and encourage future research to fill important knowledge gaps and to accomplish improvements in health and reduction in poverty in SSA.

Introduction

Health is a fundamental human right and a prerequisite for development, highly prioritized in the Millennium Development Goals (UN, 2000). Still, millions of people suffer and die every year of infectious diseases that are readily prevented or treated. Economic and social costs associated with this burden of disease may have a devastating influence on households' economies and welfare, making ill health a crucial development issue. The Commission on Macroeconomics and Health reported the economic impacts of ill health on individuals and societies as far greater than previous estimates, confirming the growing consensus of the vicious cycle of poverty and ill health (Dodd & Hinshelwood, 2004; WHO, 2001b).

There is increasing empirical evidence of a "medical poverty trap" relating to households being impoverished due to escalating out-of-pocket medical treatment costs, especially in combination with loss of income due to incapacity to work (Whitehead, Dahlgren & Evans, 2001). Earlier reviews assessing impacts of infectious diseases have focused on estimates of direct costs i.e. medical treatment and related financial costs and indirect costs i.e. productive time losses resulting from illness in general (McIntyre, Thiede, Dahlgren & Whitehead, 2006) or due to malaria, TB and AIDS (Russell, 2004) in low- and middle-income countries. Chima et al. (2003) discussed problems related to adding up direct and indirect costs as a common method of estimating the economic impacts of malaria, resulting in incorrect estimates that failed to account for the complete burden.

This study reviews the literature for evidence on impacts of infectious diseases on poverty in Sub-Saharan Africa (SSA), the region of the world carrying the heaviest burdens of disease and poverty. Around 44 percent of the population lives below the poverty line of one US \$ a day (The World Bank, 2005) and impoverishment is increasing. We focus on studies conducted in rural areas where the majority of the population lives. These areas are characterised by insufficient infrastructure, including limited access to health services, and by high dependency on agriculture. Communicable diseases like diarrhoea, lower respiratory infections, malaria, measles, tuberculosis (TB) and human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), reflecting different aspects of low standards of living, are the leading causes of morbidity and mortality (WHO, 2004).

Poor rural households have limited access to insurance and credit markets and to off-farm employment. Farm input markets tend to be imperfect and seasonality and risk in agricultural production cause a need to store food and assets as a means of consumption smoothing and insurance. Seasonality in agriculture, transaction costs and asymmetric information cause imperfections in labour markets, make hiring of labour difficult and cause hired labour to be an imperfect substitute to family labour (Feder, 1985; Holden, Shiferaw & Pender, 2004).

A fundamental consequence of these market imperfections is that production and consumption decisions of households become non-separable, implying that poverty and health shocks will affect production decisions of households and consequently their

income (Dercon, 2005). This connection complicates the analyses of impacts of ill health considerably. Furthermore, the variation in household characteristics, agro-ecological conditions, market and other institutional characteristics across households, communities, regions and countries makes it more difficult to generalise findings from one household and location to another. The ways households respond to health shocks depend on these characteristics and affect their vulnerability (Dercon & Hoddinott, 2003). The main coping responses to ill health include taking care of the sick, labour substitution within the household to reduce the production loss, borrowing or selling assets to mobilize resources for medical treatment and possibly for hiring of labour. This illustrates the interdependence of time and cash allocation of households to cope with the impacts of illness.

Our study reviews the literature to provide empirical evidence of impacts of infectious diseases on household behavior in terms of a) time allocation and labor use, b) household cash allocation, c) production responses and d) other coping responses. Based on the findings we assess the geographical coverage of studies in SSA for the major infectious diseases, the coverage by type of responses, and the extent to which findings are generalisable to other geographical areas in SSA. We critically assess the quality of the identified studies in terms of their ability to identify and quantify impacts. Important knowledge gaps are identified and recommendations for future research given.

Conceptual framework

Drawing on standard micro-economic theory adapted to a low-income country setting, we developed a conceptual model for rural households to guide the review (Becker, 1965; Pitt, Rosenzweig & Hassan, 1990; Singh, Squire & Strauss, 1986). The model aims to establish linkages between ill health and variables concerning household production and consumption. A simplified illustration of the model is given in Figure 1.

In rural SSA households are the main “economic decision managing group” defined as a group of individuals – most commonly linked by kinship ties – who live together and share functions of production and consumption (Bender, 1967; Sauerborn, Ibrango, Nougara, Borchert, Hien, Benzler et al. 1995). These households depend on their labour force, assets and other resources in their production and income generating activities and operate as combined production and consumption units. Agricultural production represents the main source of livelihood, both for cash income and for own food consumption. Illness due to infectious diseases is common and may affect production and income generating activities as well as consumption and investment patterns when markets are imperfect.

Households may be seen as deriving utility directly via consumption of a variety of goods and services including leisure or indirectly from income and leisure. Ill health also gives direct disutility that may be captured in the utility function. We assume that households maximize their utility subject to the constraints they face.

Typically constraints include:

- One or several production functions identifying inputs and outputs and the functional relationship between inputs and outputs. Substitutability among factors of production is one important characteristic. One may include a separate production function for health of household members (Berman, Kendall & Bhattacharyya, 1994).
- Resource endowments used as inputs in production. Endowments may change over time through consumption, investments or natural growth (e.g. livestock endowments and human capital) or through degradation or depletion (e.g. soil erosion and deforestation). Labour endowment may be captured by a time constraint that includes household leisure time.
- Seasonality of rainfall has implications for timing of production and input allocation. Scarcity of labour and returns to labour may be high in the peak seasons while labour may be abundant outside peak seasons. Timing of illness may therefore matter for the impacts of illness.
- Cash or liquidity constraints are included because poor people tend to be rationed out of credit markets and are typically cash-poor. Limited access to the labour market and to other input and output markets as well as to insurance markets should be captured to have a realistic model of the constraints and opportunities of households. The functioning of asset markets (e.g. for livestock, land, tools, other durables) affects the extent to which assets may be converted to cash upon need.
- The model needs to capture risk in various ways. This includes different types of risk (e.g. health risk, production risk, market risk and political/social risk) and *ex ante* (insurance) and *ex post* (coping) responses to risk. Health risks may have short-term and long-term impacts on the health capital of the household. Responses to risk include production and income diversification, reliance on extended family networks (social capital) and keeping of buffer stocks. These insurance mechanisms have their costs. When inter-temporal markets (insurance and credit markets) do not work well, this may affect ability and willingness to invest and smooth consumption over time.
- Income and budget constraints.

We may think of two situations where production is unaffected by ill health. The first case is with perfect markets where the labour market ensures that sick persons are substituted for. The second case is when labour is abundant so that other household members substitute for the sick person. The latter situation is more likely to be relevant in SSA and may reduce production losses on a short-term basis. However, heavy burdens of disease combined with seasonality peaks in agriculture and imperfect credit and labour markets, may create household-specific labour shortages. This may cause long-term negative impacts on households e.g. children and adolescents drop out of school to substitute for ill working-age adults (UN, 2004) and increased burdens on women as predominantly caretakers inducing wider gender gaps in human capital (Mesko, Wiegers & Hermanrud, 2003; Schultz, 2001).

Materials and methods

A comprehensive and systematic literature review was conducted, directed by the conceptual framework. Primary research studies assessing the impacts of infectious diseases at household level in rural SSA concerning effects on a) time allocation and labor use, b) cash allocation, c) production responses, and/or d) other coping responses, were selected for the review. Infectious diseases are limited to diarrhoeal diseases, HIV/AIDS, lower respiratory infections, malaria, schistosomiasis and tuberculosis, representing the dominating communicable diseases. Papers that assessed impacts of illness in general without specifying any type of diseases or surveys conducted in urban populations in SSA were not included, nor were impact studies conducted at macroeconomic level.

Studies were identified using electronic databases, mainly PubMed, Science Direct, ISI Web of Knowledge, JSTOR and Google Scholar using a range of keywords relating to impacts of infectious diseases. Terms like “impact”, “economic impact”, “cost of illness”, “burden of illness” were used in combination with “infectious disease”, “communicable disease” or name of included diseases like “malaria” and “AIDS”. Key websites from the World Bank, World Health Organization and the United Nations, and other internet sites likely to provide relevant information were consulted in addition to a network of colleagues. Furthermore, a secondary search of the bibliographies of relevant studies was carried out. Articles or reports not written in English or a Scandinavian language were excluded. The findings of each individual study were classified and presented in tabular form.

Results

We found 17 studies that satisfied our inclusion criteria (Table 1). The table provides information about the geographical location and coverage, study design, and impacts per disease. Three studies (Amacher, Ersado, Hyde & Osorio, 2004; Ersado, 2005; Ersado, Amacher & Alwang, 2004) are based on the same dataset and are partially overlapping. These papers are treated as one study, reducing the number of included studies to 15.

Study design

Twelve studies applied cross-sectional study design on household level (Table 1). Two studies combined cross-sectional data with health monitoring during 10-12 months (Audibert, Mathonnat & Henry, 2003; Girardin, Dao, Koudou, Esse, Cisse, Yao et al. 2004), one with a time allocation study at health care facilities (Asenso-Okyere & Dzator, 1997), Audibert (1986) with time-series observations in agricultural production over five years, and Sauerborn et al. (1991) with national statistical data. Ngalula et al. (2002) chose a community cohort study in combination with a demographic surveillance system.

Longitudinal design was applied in two studies, Nur (1993) collected data for a year to capture seasonal variations, while Yamano & Jayne (2004) used a two-year panel of household data and the difference-in-difference method to estimate impacts.

Geographical coverage by disease

Out of the 15 studies included, nine assessed effects of malaria, three of AIDS, two of malaria and schistosomiasis combined, and one of a combination of several diseases (Table 1). The studies on malaria were conducted in nine different countries out of which only one study, originating from Malawi, had a national coverage. Two studies on AIDS were carried out in Tanzania and one in Kenya, the latter the only nationwide survey. The review revealed no study that assessed impacts of tuberculosis in rural areas of SSA.

Coverage by effects studied

Table 1 gives an overview of the studies in terms of whether they focused on household time allocation, cash allocation, production responses and/or coping responses. Overall we see that 11 studies included information on time allocation, out of which six valued the time loss due to sickness. Twelve studies addressed cash allocation, seven surveys assessed production responses and seven other coping responses. However, when we take into account that different diseases have different implications for time and cash allocation, and production and coping responses vary across geographical locations, many knowledge gaps appear. Particularly, the information is limited for the least studied diseases and for production and coping responses.

Effects studied for malaria

Seven malaria studies estimated work time lost due to illness (Table 1). Out of these, four studies estimated total sick days for patient and caretaker combined, two studies stratified on patient and caretaker and gender and/or age, and one study included time lost only for patients. One study estimated partially incapacitated working time while one study distinguished between mild and severe malaria cases. Only two studies had any data on labor substitution. Illness was reported either per case, per two weeks, per one, six or ten months, per cropping season or per year with recall periods varying from two weeks to two years. Five studies estimated the value of time lost using five different approaches to calculate a monetary value. The great variation in units of analysis, make comparison of results difficult.

Estimates of direct financial costs due to illness were given in five papers out of which two distinguished between mild and severe cases. Out-of-pocket expenditures could include drugs and treatment, fees at laboratories and clinics, transport to health care facilities, food and lodging when seeking treatment, and preventative measures like bednets and mosquito coils. Which expenditures were included for the patients and/or the caretakers vary from survey to survey and are often not reported in detail, adding weight to the challenging comparison of results.

Only four studies assessed the impact of malaria on farm production. Two of the studies found a negative correlation (Audibert et al., 2003; Girardin et al., 2004) while two found no significant effects (Audibert, 1986; Wang'Ombe & Mwabu, 1993). The latter studies indicated that limitations in the study design could explain the unexpected result.

Coping strategies were assessed in five studies, two concerning labor substitution and three addressing preventative malaria measures. One study indicated that the value Ethiopian households put on preventative malaria measures were twice the expected household cost of illness (Cropper, Haile, Lampietti, Poulos & Whittington, 2004).

Effects studied for AIDS

Estimates of duration of illness were given as percent of cases that had been ill for more than three months or as average workdays lost for patients and caretakers (Table 1). Two thirds of the cases in Kagera, Tanzania had more than one caretaker and on average 43 % of the household labor stock was devoted to caretaking during the period of terminal illness (Tibaijuka, 1997). Treatment and funeral costs per AIDS patient were almost equal to per capita income or annual household cash income, pushing households into lower income strata and forcing them to sell livestock and land to manage the payments. The patients' families i.e. parents and siblings, are the main contributors to finance illness related costs, only one out of a hundred cases received financial support from outside of the family (Ngalula, Urassa, Mwaluko, Iningo & Boerma, 2002).

The survey from Kenya focused on the impacts of working-age adult mortality on households' ability to generate income (Yamano & Jayne, 2004). The impacts were highly sensitive to the gender and position of the deceased family member in the household (Table 1). Male mortality had higher negative financial impacts compared to female mortality and led to conversion from high value crop to low value cereals as a consequence of gender division in labor.

Effects studied for combinations of diseases

Audibert (1986) used a production function to confirm and measure a negative effect of health status on productivity among self-employed rice-growers in Cameroon (Table 1). Linkages between health status, irrigation dams and agricultural production were addressed within a household production framework in Ethiopia (Amacher et al., 2004; Ersado, 2005; Ersado et al., 2004). Water borne diseases like malaria and schistosomiasis that were enhanced by the dams, increased health expenditure, decreased labor productivity, and were found to have a negative impact on adoption of more efficient farming practices. Productivity losses for males were twice the size as for females. Furthermore, decline in labor allocation to off-farm activities resulted in reduced off-farm income. Sauerborn et al. (1995) assessed economic costs of illness in general, and reported malaria, diarrhea and respiratory infections on the top of the list of acute illnesses and schistosomiasis as the most frequent chronic disease. Total monthly cost of illness amounted to 3.7 % of household income.

Discussion

Geographical coverage and knowledge gaps

This review revealed merely 15 studies conducted in ten of 47 Sub-Saharan African countries. Only two of the studies had a national coverage, one assessed the impacts of malaria in Malawi (Ettling, McFarland, Schultz & Chitsulo, 1994) and another the impacts of adult mortality due to AIDS in Kenya (Yamano & Jayne, 2004). The remaining studies covered smaller districts or regions within a country. Given the large variation in disease patterns and dynamics and the spectra of coping responses across households, communities, regions and countries, generalising results from a few specific locations and settings requires special care.

Two thirds of the included studies assessed economic effects of malaria. Estimates show that the protozoa *Plasmodium falciparum* caused 365 million clinical malaria episodes in SSA in 2002 (Snow, Guerra, Noor, Myint & Hay, 2005). Several authors argue that both disease epidemiology and seasonality in agriculture must be considered when assessing the impacts of illness on household poverty (Audibert, 1986; Girardin et al., 2004; Nur, 1993; Onwujekwe, Chima & Okonkwo, 2000; Sauerborn, Shepard, Ettling, Brinkmann, Nougara & Diesfeld, 1991). The variation in household characteristics within communities in combination with seasonality and market imperfections cause the impacts of ill health to be household specific. Impact assessment requires identification of households with similar characteristics within the same locality to establish good counterfactuals. When it is difficult to generalise across households within communities, how is it to generalise from one community to another and from one country to another? For malaria, the most studied of the infectious diseases in SSA there exists only one nationally representative study, that in Malawi. Estimates of the economic costs of malaria range from 0.6% (Shepard et al. 1991) of GDP based on microeconomic studies in some African countries to much higher values in some macroeconomic cross-country studies (Malaney et al. 2005).

When uncertainty about the impact is so large for the most studied disease it is not likely to be less for less studied diseases that also are characterised by variation in geographical dispersion, the severity of illness across individuals and households, and its interactions with various household characteristics. E.g. adult mortality due to AIDS may have very different impacts on households depending on the number of adults, number of children, their age, and wealth status, access to employment and medical care, and social networks. We identified one sole nationally representative study of this in SSA, carried out in Kenya (Yamano & Jayne, 2004). The study revealed severe negative effects of adult mortality on household income.

For tuberculosis, lower respiratory infections and diarrhoea, we found no separate impact studies. For schistosomiasis we found one small study in Cameroun and a couple of other studies that combined studies of schistosomiasis and other diseases. In other words, here are large knowledge gaps when it comes to assessing the impacts of these diseases on household poverty, time allocation, production and coping behaviour. These knowledge gaps make it very difficult to estimate the impacts on these poverty

indicators of interventions that aim to reduce the extent of these diseases. Furthermore, it makes it impossible to know how to best allocate scarce public health funds and harder to argue for increased funding of public health interventions aiming at poverty reduction through improvements in health.

Diversity of study design

This review has, like other reviews (Chima, Goodman & Mills, 2003; McIntyre et al., 2006; Russell, 2004), revealed a large degree of heterogeneity in study design among studies, making comparison of results and deriving reliable conclusions difficult. When a family member falls ill, the coping responses vary with the role and function of the sick person in the household e.g. a sick child or a sick working age adult triggers different responses. Coping strategies are seeking to sustain the economic welfare of the household and are influenced by disease type, severity and duration and by the household's vulnerability or ability to cope with ill health (Sauerborn, Adams & Hien, 1996). It is therefore important to collect time allocation data for all household members affected and not only for the patient to get a complete impact assessment. The included studies stratified differently on patients and caretakers, on gender and age, and on record periods regarding specifications of sick days. Similar diversity was found for estimates of direct financial costs and in converting work time lost into monetary values (Table 1). A standardisation of definitions and methods used to measure and quantify impacts of illness is needed in order to compare results and scale up research.

Methodological quality of studies

Various methods exist for estimation of impacts from non-experimental data. Each method has its strengths and weaknesses but choice of method depends on availability of data and purposes of the analysis. For analyses of single cross-section data instrumental variable and Heckman selection models have been commonly used to control for endogeneity and selection bias (Heckman, 1979; Wooldridge, 2002). Both types of models depend on strong assumptions and have their clear limitations in the case of heterogeneous effects of infectious diseases. Endogeneity of ill health in cross-sectional studies may not easily be controlled for as it may be difficult to find good instruments to predict it. Controlling for selection bias in relation to impact assessment of ill health therefore becomes crucial but also difficult. When the probability of being infected is not random but a function of the characteristics of individuals, households and their environment, some of these characteristics that vary systematically with the probability of being infected may be unobservable. It is this unobservable correlation that leads to selection bias. Finding an observed variable that is correlated with the unobserved variables but uncorrelated with the outcome variable is required to correct for this selection bias. It may not be easy in practice.

With the availability of repeated cross-sectional data (household panel data) it is possible to apply other methods that are less restrictive in their assumptions. Such methods include the Difference-in-Difference (DiD) method, matching methods (e.g. based on propensity score matching), and combinations of these methods (Blundell & Costa Dias, 2000; Ravallion, 2006). The DiD method allows to control for individual

time-invariant effects and common macro-effects but not for time-varying individual effects. With heterogeneous effects of infectious diseases the DiD method can only estimate the effect of infectious diseases on the infected person. The average population effect cannot be identified. The matching method based on propensity score matching may be used to identify counterfactual (unaffected) households to those affected by infectious diseases. These counterfactual households are identified based on observable characteristics. It rests on the assumption that the only remaining differences are due to the infectious disease. This method relies on the possibility to identify good matches to those households that are infected and on the absence of selection bias related to unobservable characteristics.

To what extent have the studies included in this review used appropriate survey and estimation methods to assess the impacts of infectious diseases on the variables we are interested in? We found that 12 out of the 15 studies have used single cross-sectional household surveys as a basis for their analysis, one study used a two-period panel of households (and applied the DiD-method), one used a longitudinal study of one year to get information on the seasonal variation, and one used a community cohort study combined with a demographic surveillance system.

It is highly questionable whether the cross-sectional studies have been able to identify impacts rather than correlations and whether these “so-called” impacts are unbiased estimates of the impacts. At best the studies may say something about the impact of infectious diseases on the affected households. Generalisations from those households to other households within the same communities, or to other communities or countries are clearly ill-founded as the homogenous impacts effect assumption does not hold in these environments. The fact that causality between health and poverty goes in both directions may cause the long-term impacts of infectious diseases to be stronger than becomes evident from analyses of cross-sectional data. This may also explain some of the gap between the findings in microeconomic studies vs. macroeconomic studies (Malaney P, Spielman A & Sachs J, 2004).

The sole nationwide study of economic impacts of malaria that we identified (Ettling et al., 1994) established that expenditures on malaria treatment were very high for the very low income households (28% of total household income) and the total costs were estimated to 32% of total income of these households. This was based on a loss of 28 days per household, each valued at 0.075 \$/day. The latter value of time was only based on average income of these households and did not establish any causality between the illness and its impact on production or income of the households. Clearly, this does not give a basis for saying anything about the production effect of an intervention that would reduce the number of sick days of these households although it may say something about the reduced need for malaria treatment expenditure. The study revealed clearly that the poorest suffered much more from malaria than the less poor households as they had to give up a much larger share of their income in order to get treatment.

The only study that applied the DiD-method to assess impacts of adult mortality (mostly caused by AIDS) at national level in Kenya (Yamano & Jayne, 2004) is a credible attempt to estimate the impact of AIDS on household farm production, asset holdings,

and non-farm income. By disaggregating the effects by gender and status of those who died the study reveals interesting information on such heterogeneity and its impact implications. As discussed in the study, working-age adult mortality cannot be considered as a random shock to households due to two sources of selection problems; household and individual characteristics that are correlated with working-age adult mortality; and household characteristics that affect the likelihood of offering terminal care. Given that these are time-invariant characteristics this selection problem is controlled for by the DiD-method. In addition time*village dummies were included together with dummy variables for adult deaths in ordinary least squares regressions to control for time-variant village effects. The analyses revealed strong negative effects of death of the household head on gross (- 57%) and net value (- 68%) of crop output. The study revealed that fairly large samples are needed to make the kind of effects studied statistically significant. Mostly, this is due to the relative small sub-sample of households that have experienced adult deaths in the period between 1997 and 2000 when the surveys were carried out.

The way forward: Better research designs and scaling up: Why is it so difficult?

Why such a lack of good studies and vast knowledge gaps when it comes to some of the most common infectious diseases that the poor suffer from? Why have not governments and international organisations given more priority to identifying the economic and welfare consequences of these diseases? This is more remarkable than ever given the strong focus on poor health as an important aspect of poverty and the strong focus on health in the world development agenda.

The obvious way forward seems to be to;

- Integrate health surveys and household production and consumption surveys at national level
 - Repeat these surveys regularly to develop household panel data that combine comprehensive data on
 - Household production activities (farm plot level)
 - Household consumption (taking intra-household distribution issues into account)
 - Household health assessment for household members
 - Village and environmental characteristics
 - Other institutional, program and policy characteristics
- Use more appropriate impact assessment methodologies like the DiD method and matching methods in the analyses
- Combine baseline studies with randomly assigned experimental studies
 - Good baseline surveys should be used to establish a proper counterfactual before introducing random experiments to test out and measure the impact of alternative health interventions

More than two decades ago articles were published drawing on meetings and discussions in the Scientific Working Group on Social and Economic Research (UNDP/World Bank/WHO, 1980), proposing conceptual and methodological frameworks to systematically analyze the impacts of tropical diseases on individuals

and households (Popkin, 1982; Rosenfield, Golladay & Davidson, 1984). Popkin proposed to focus on “the relationships between tropical diseases and their effects on the health status and functional capacity of individuals and ultimately on the social and economic performance of individuals and households by using a broadly conceptualized new home economics framework”. In his article he discussed research design and data considerations including time allocation and labor use and household cash allocation in home and market activities. Rosenfield et al. (ibid) pointed at the need for interdisciplinary and close collaboration to “ensure completeness and reliability of input data and results”. Inter- and multidisciplinary research approaches allows more complete empirical analyses of complex issues like the impacts of infectious diseases on poverty. These recommendations have apparently not been implemented at a large scale. Reviewing the literature in the early nineties, Sauerborn et al. (1995) drew similar conclusions as they could not detect any study providing a complete assessment of economic costs at household level related to the impact of illness. They only located studies dealing with partial evaluations.

This indicates that our ideas are far from new. We suggest some explanations for this apparent inability to act that also may give a basis for action to change the sad state of affairs;

- Slow institutional adjustment and difficulties of operationalising the expanded poverty perspectives are reported (Kapiriri & Norheim, 2002; Laterveer, Niessen & Yazbeck, 2003; Leon, Walt & Gilson, 2001; WHO, 2001a). It is a slow process to change the way national statistical data are collected. The proposed approach requires a revolutionary change in the collection of such data.
 - Many interest groups both inside and outside the statistical offices may resist such a change because it may be feared that it is at the expense of other priorities
 - Statistical offices may lack the broad multi- and interdisciplinary knowledge that is required to establish such new national surveys
- Disciplinary focus has for long dominated in medical and social sciences. Lack of inter- and multidisciplinary cooperation and non availability of suitable datasets to analyse relationships between health and poverty are suggested as inhibiting factors (Diamond, Matthews & Stephenson, 2001; Falkingham & Namazie, 2002; Verheul & Rowson, 2002). The kind of interdisciplinary research that is proposed here has therefore had a fairly low status and not attracted sufficient attention by researchers or funding agencies.
- Diversity in research methods and study design make comparison of results very difficult, like we see clearly in this review. Difficulties with research design and targeting e.g. reaching the poor, limits desired research (Castro-Leal, Dayton, Demery & Mehra, 2000). Consensus on methods for analysis of impacts of ill health on poverty will be a step in the right direction to fill knowledge gaps.

Will these actions be too costly and too knowledge demanding? Or will it be more costly not to go for them? Can costs of learning be reduced? Can best-practice projects be used to stimulate learning and set better standards for this type of applied health research? These are questions for debate and future research in a global context.

Conclusions

The main finding of this review is the shortage of relevant studies and the great variation in methodological design when assessing the impact of infectious diseases on household poverty in SSA. The complexity of the health-poverty linkages and their variation across health problems and households in different community settings requires special attention. International and national research efforts need to develop a common impact assessment approach to allow valuable comparisons of households' economic burden of illness across diseases and settings. Improved knowledge about the impact of communicable diseases on household level is needed in order to minimise the consequences of illness and target interventions more efficiently.

References

- Amacher,G., Ersado,L., Hyde,W., & Osorio,A. (2004). Tree planting in Tigray, Ethiopia: the importance of human disease and water microdams. *Agroforestry Systems*, 60(3), 211-225.
- Asenso-Okyere,W.K., & Dzator,J.A. (1997). Household cost of seeking malaria care, a retrospective study of two districts in Ghana. *Social Science & Medicine*, 45(5), 659-667.
- Audibert,M. (1986). Agricultural non-wage production and health status - A case study in a tropical environment. *Journal of Development Economics*, 24(2), 275-291.
- Audibert,M., Mathonnat,J., & Henry,M.C. (2003). Social and health determinants of the efficiency of cotton farmers in Northern Cote d'Ivoire. *Social Science & Medicine*, 56(8), 1705-1717.
- Becker,G.S. (1965). A Theory on the Allocation of Time. *The Economic Journal*, 75 493-517.
- Bender,D.R. (1967). A Refinement of the Concept of Household: Families, Co-Residence, and Domestic Functions. *American Anthropologist*, 69(5), 493-504.
- Berman,P., Kendall,C., & Bhattacharyya,K. (1994). The household production of health: Integrating social science perspectives on micro-level health determinants. *Social Science & Medicine*, 38(2), 205-215.
- Blundell,R., & Costa Dias,M. (2000). Evaluation Methods for Non-Experimental Data. *Fiscal Studies*, 21(4), 427-468.
- Castro-Leal,F., Dayton,J., Demery,L., & Mehra,K. (2000). Public spending on health care in Africa: do the poor benefit? *Bulletin of the World Health Organization*, 78(1), 66-74.

- Chima,R.I., Goodman,C.A., & Mills,A. (2003). The economic impact of malaria in Africa: a critical review of the evidence. *Health Policy*, 63(1), 17-36.
- Cropper,M.L., Haile,M., Lampietti,J., Poulos,C., & Whittington,D. (2004). The demand for a malaria vaccine: evidence from Ethiopia. *Journal of Development Economics*, 75(1), 303-318.
- Dercon,S. (2005). Insurance against poverty. Oxford: Oxford University Press.
- Dercon,S., & Hoddinott,J. (2003). Health, Shocks and Poverty Persistence. Helsinki: United Nations University.
- Diamond,I., Matthews,Z., & Stephenson,R. (2001). Assessing the health of the poor: towards a pro-poor measurement strategy. London: Department for International Development.
- Dodd,R., & Hinshelwood,E. (2004). Poverty Reduction Strategy Papers: Their Significance for Health - second synthesis report. Geneva: World Health Organization.
- Ersado,L. (2005). Small-scale irrigation dams, agricultural production, and health: Theory and evidence from Ethiopia. Washington: The World Bank.
- Ersado,L., Amacher,G., & Alwang,J. (2004). Productivity and Land Enhancing Technologies in Northern Ethiopia: Health, Public Investments, and Sequential Adoption. *American Journal of Agricultural Economics*, 86(2), 321-332.
- Ettling,M., McFarland,D.A., Schultz,L.J., & Chitsulo,L. (1994). Economic impact of malaria in Malawian households. *Tropical Medicine and Parasitology*, 45(1), 74-79.
- Falkingham,J., & Namazie,C. (2002). Measuring health and poverty: a review of approaches to identifying the poor. London: Department for International Development.
- Feder,G. (1985). The Relation Between Farm Size and Productivity: the role of family labor, supervision, and credit constraints. *Journal of Development Economics*, 18 297-313.
- Girardin,O., Dao,D., Koudou,B., Esse,C., Cisse,G., Yao,T., N'Goran,E., Tschannen,A., Bordmann,G., Lehmann,B., Nsabimana,C., Keiser,J., Killeen,G., Singer,B., Tanner,M., & Utzinger,J. (2004). Opportunities and limiting factors of intensive vegetable farming in malaria endemic Cote d'Ivoire. *Acta Tropica*, 89(2), 109-123.
- Heckman,J.J. (1979). Sample Selection Bias as a Specification Error. *Econometrica: Journal of the Econometric Society*, 47(1), 153-162.
- Holden,S.T., Shiferaw,B., & Pender,J. (2004). Off-farm Income, Household Welfare and Sustainable Land Management. *Food Policy*, 29 369-392.

- Kapiriri,L., & Norheim,O.F. (2002). Whose priorities count? Comparison of community-identified health problems and Burden-of-Disease-assessed health priorities in a district in Uganda. *Health Expectations*, 5(1), 55-62.
- Laterveer,L., Niessen,L.W., & Yazbeck,A.S. (2003). Pro-poor health policies in poverty reduction strategies. *Health Policy and Planning*, 18(2), 138-145.
- Leon,D.A., Walt,G., & Gilson,L. (2001). Recent advances: International perspectives on health inequalities and policy. *British Medical Journal*, 322(7286), 591-594.
- Malaney P, Spielman A, & Sachs J (2004). The malaria gap. *American Journal of Tropical Medicine and Hygiene*, 71(2 Suppl), 141-146.
- McIntyre,D., Thiede,M., Dahlgren,G., & Whitehead,M. (2006). What are the economic consequences for households of illness and of paying for health care in low- and middle-income country contexts? *Social Science & Medicine*, 62(4), 858-865.
- Mesko,N., Wieggers,E., & Hermanrud,V. (2003). HIV/AIDS and Agriculture: Impacts and Responses. Case Studies from Namibia, Uganda and Zambia. (pp.1-34). Rome: Food and Agricultural Organization.
- Ngalula,J., Urassa,M., Mwaluko,G., Isingo,R., & Boerma,J.T. (2002). Health service use and household expenditure during terminal illness due to AIDS in rural Tanzania. *Tropical Medicine & International Health*, 7(10), 873-877.
- Nur,E.T.M. (1993). The impact of malaria on labour use and efficiency in the Sudan. *Social Science & Medicine*, 37(9), 1115-1119.
- Onwujekwe,O., Chima,R., & Okonkwo,P. (2000). Economic burden of malaria illness on households versus that of all other illness episodes: a study in five malaria holo-endemic Nigerian communities. *Health Policy*, 54(2), 143-159.
- Pitt,M.M., Rosenzweig,M.R., & Hassan,Md.N. (1990). Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries. *The American Economic Review*, 80(5), 1139-1156.
- Popkin,B.M. (1982). A household framework for examining the social and economic consequences of tropical diseases. *Social Science & Medicine*, 16(5), 533-543.
- Ravallion,M. (2006). Evaluating anti-poverty programs. In R.E. Evenson, & T.P. Schultz (Eds.), *Handbook of Agricultural Economics Volume 4*. Amsterdam: Elsevier.
- Rosenfield,P.L., Golladay,F., & Davidson,R.K. (1984). The economics of parasitic diseases: Research priorities. *Social Science & Medicine*, 19(10), 1117-1126.
- Russell,S. (2004). The economic burden of illness for households in developing countries: A review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. *The American journal of tropical medicine and hygiene*, 71(2), 147-155.

- Sauerborn,R., Adams,A., & Hien,M. (1996). Household strategies to cope with the economic costs of illness. *Social Science & Medicine*, 43(3), 291-301.
- Sauerborn,R., Ibrango,I., Nougara,A., Borchert,M., Hien,M., Benzler,J., Koob,E., & Diesfeld,H.J. (1995). The Economic Costs of Illness for Rural Households in Burkina-Faso. *Tropical Medicine and Parasitology*, 46(1), 54-60.
- Sauerborn,R., Shepard,D.S., Ettlign,M.B., Brinkmann,U., Nougara,A., & Diesfeld,H.J. (1991). Estimating the direct and indirect economic costs of malaria in a rural district of Burkina Faso. *Tropical Medicine and Parasitology*, 42(3), 219-223.
- Schultz,T.P. (2001). Women's Role in the Agricultural Household: Bargaining and Human Capital. In B.L. Gardner, & G.C. Rausser (Eds.), *Handbook of Agricultural Economics Volume 1 Part 1* (pp.383-456). Amsterdam: Elsevier.
- Singh,I., Squire,L., & Strauss,J. (1986). *Agricultural Household Models. Extensions, Applications, and Policy*. Baltimore: Johns Hopkins University Press.
- Snow,R.W., Guerra,C.A., Noor,A.M., Myint,H.Y., & Hay,S.I. (2005). The global distribution of clinical episodes of Plasmodium falciparum malaria. *Nature*, 434(7030), 214-217.
- The World Bank (2005). *World Development Indicators*. Washington: The World Bank.
- Tibaijuka,A.K. (1997). AIDS and economic welfare in peasant agriculture: Case studies from Kagabiro village, Kagera region, Tanzania. *World Development*, 25(6), 963-975.
- UN (2000). *United Nations Millennium Declaration*. New York: United Nations.
- UN (2004). *The Impact of AIDS*. New York: United Nations.
- UNDP/World Bank/WHO (1980). *Report of the Second Scientific Working Group on Social and Economic Research: Guidelines to Assess the Social and Economic Consequences of the Tropical Diseases*. Geneva: World Health Organization.
- Verheul,E., & Rowson,M. (2002). Editorial: Where is health? *Tropical Medicine & International Health*, 7(5), 391-394.
- Wang'Ombe,J.K., & Mwabu,G.M. (1993). Agricultural land use patterns and malaria conditions in Kenya. *Social Science & Medicine*, 37(9), 1121-1130.
- Whitehead,M., Dahlgren,G., & Evans,T. (2001). Equity and health sector reforms: can low-income countries escape the medical poverty trap? *The Lancet*, 358(9284), 833-836.
- WHO (2001a). *Health in PRSPs: WHO Submission to World Bank/IMF Review of PRSPs*. Geneva: World Health Organization.

WHO (2001b). *Macroeconomics and Health: Investing in Health for Economic Development - Report of the Commission on Macroeconomics and Health*. Geneva: World Health Organization.

WHO (2004). *World Health Report 2004*. Geneva: World Health Organization.

Wooldridge, J.M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge: MIT Press.

Yamano, T., & Jayne, T.S. (2004). Measuring the Impacts of Working-Age Adult Mortality on Small-Scale Farm Households in Kenya. *World Development*, 32(1), 91-119.

Figure 1
Simple illustration of conceptual model for rural households

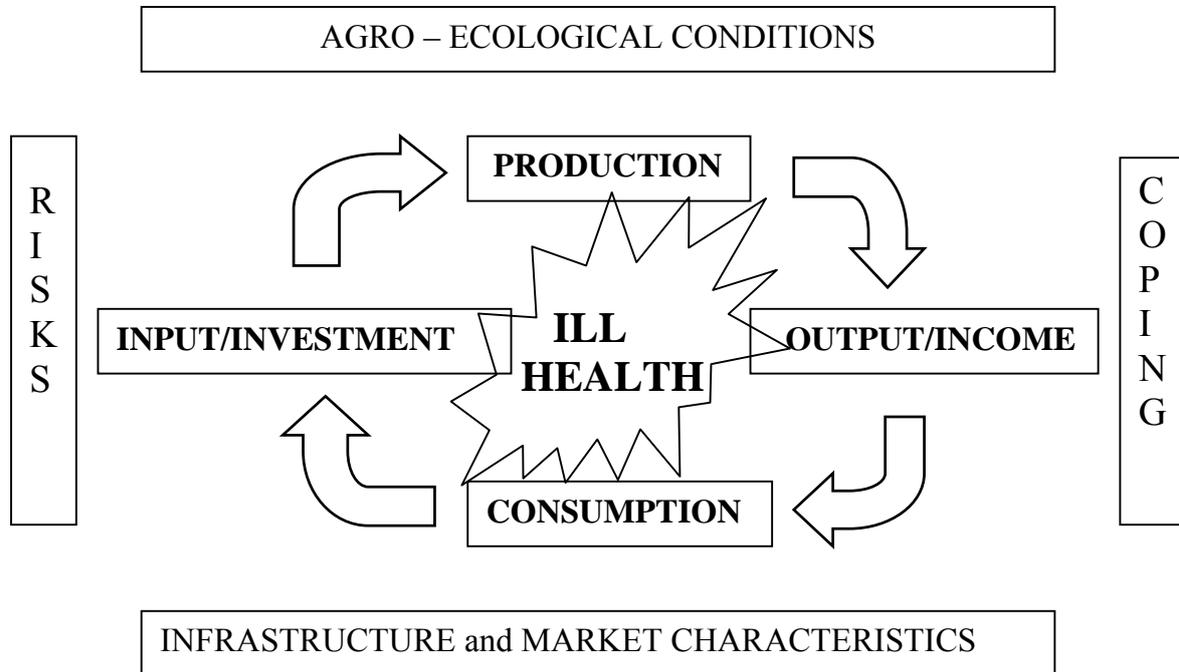


Table 1
 Studies on impacts of infectious diseases classified by response type

IMPACTS OF MALARIA					
Authors Country	Study design	Time allocation and labour use	Cash allocation	Production responses	Other coping responses
Asenso- Okyere & Dzator (1997)	Cross-sectional household survey (CS)	Sick (caretaking) days per case: 1.8 (3.2) Recall 1 month	Value of days lost (by average agricultural adult wage rate): US \$ 6.87 ~ 79% of total costs Treatment costs per mild/severe case: US \$ 3.23/6.40 (drugs comprise 60 %) Total cost: US \$ 8.67 ~ 4.7 /3.7 days of female/male output (US \$ 1993 rate)		
Ghana (2 districts)					
Audibert et al. (2003)	CS	High density malaria infection had a significant negative impact on the probability of sowing early		Early sowing of cotton increased pure technical efficiency by 15%	
Cote d'Ivoire (1 region)				High density malaria	

infection was associated with 16% lower total efficiency and 8% lower pure technical efficiency

<p>Cropper et al. (2004) Ethiopia (1 region)</p>	<p>CS</p>	<p>Sick (caretaking) days per adults/teenagers/children per case: 18(11)/18(13)/2(11) Labour substitution days: 8/5/0 Recall 2 years</p>	<p>Value of days lost (by daily wage of an unskilled worker): US\$ 6-22/6-22/3-12 Treatment costs: US \$ 1.6/1.1/0.8 15 % of household income lost to malaria annually (US \$ 1997 rate)</p>	<p>Preventative measures: 44 % drained ditches 7 % used prophylactic medicine</p>
<p>Ettling et al. (1994) Malawi (Nationwide)</p>	<p>CS</p>	<p>Sick + caretaking days ages \leq 10/$>$ 10 years for very low income (low to high income) households per case: 1.4 /2.9 (1.0/2.4) Episodes per year: 7.5/6.1 (7.5/6.1) Days lost per year: 28 (22) Recall 2 years</p>	<p>Value of days lost (by average household income) per year: US \$ 2.13 (20.61) Treatment costs: US \$ 19.13 (19.94) ~28 (2) % of annual income Total cost per year: US \$ 21.9 (45.3) ~ 32 (4.7) % of annual income (US \$ 1992 rate)</p>	<p>10 % of households purchase preventative methods like bednets, mosquito coils or aerosol spray</p>

Girardin et al. (2004)	CS	Sick days per 10 months: 8.3	53% lower revenues of vegetable production	47% lower yield	Preventative measures: 18% bednets 11% fumigating coils 9% insecticide sprays 52% no preventative measures
Côte d'Ivoire (1 village)		Strong correlation between health status of farmers and intensive vegetable production	when comparing > 2 sick days (mean 4.2 days) with < 2 sick days (mean 0.3 days)		
Nur (1993)	Longitudinal household survey	Sick/(caretaking) hours per male/female/children per year: 18.1(2.5)/13.1(2.4)/1.6(0.4)			
Sudan (1 state)		Partially incapacitated working hours per person: 5.2 (80 % among age 18-60 years)			
		Family labour substitution hours: 2.1/23.8/15.2			
		Hours spent visiting sick relatives: 68.2/60.3/2.6			
Onwujekwe et al. (2000)	CS	Sick (caretaking) days per month: 4-9 (5-9)	Value of days lost (by official minimum wage rate): US \$ 2.8-5.7 ~ 2.6 % of annual income		
Nigeria (1 state)		> 75 % of patients lost workdays			
		33-60 % of households incurred treatment costs	Treatment costs: US \$ 3.0-8.8 ~ 2.9 % of monthly income (US \$ 1998 rate)		

Sauerborn et al. (1991)	CS	Sick (caretaking) days per mild/severe case: 1.0 (0.3) / 5.0 (1.7)	Value of days lost (by marginal product of labor): US \$ 0.72 / 3.62		
Burkina Faso (1 region)		Recall 2 weeks /6 months	Treatment costs: US \$ 0.82 / 4.21 ~ 1.9 % of annual adult output		
		Loss of lifetime production due to fatal malaria in 0.5 % of cases	Loss of lifetime production due to premature death: US \$ 842 per child (US\$ 1987 rate)		
Wang'Ombe & Mwabu (1993)	CS	1,5 malaria episodes each month per household	No significant effect on total household income	No significant effect on cassava production	78-90 % of households used preventative measures
Kenya (2 districts)		Recall 3 months			

IMPACTS OF AIDS

Authors Country	Study design	Time allocation and labour use	Cash allocation	Production responses	Other coping responses
Ngalula et al. (2002)	Community cohort study	86 % of deaths (n=73) at ages 15-59 years had been ill > 3 months	Treatment costs per case: US \$ 49 ~ 64 % of local per capita income		Family contributed to costs in 82 % of cases
Tanzania (1 ward)					Sale of property to cover costs in 29 % of cases

			Funeral costs: US \$ 31		Received financial support outside family in 1 % of cases
			Deceased or spouse primary source of costs in 37 % of cases		
			(US \$ 1996-98 rate)		
Tibaijuka (1997)	CS	Workdays lost per case at ages 0-65 years due to terminal illness/caretaking/mourning: 5.4 months/5.4 months/5.2 days	Treatment + funeral costs: TSh 35000 ~ 96 % of average annual household cash income	10 % decrease in farm size	Sources of fund for costs (cases): sale of staple food (all) sale of assets (8) sale of animals (6) family savings (5) sale of land (4) sale of farm (3) borrowing (2)
Tanzania (1 region)		> 1 caretaker in 66 % of cases	9 of 10 households pushed into lower income stratum		
		43 % of labour stock devoted to caretaking	(TSh 1989 rate)		
		38 % decrease in household labour stock			
		34 % increase in dependency burden			

Yamano & Jayne (2004) Kenya (Nationwide)	Two-year household panel	Reduction in household size after death of male/female head of household: 1.5/2.1 members	Death of male head-of household: Gross crop output/net value of crop production/ off-farm income/ value of farm equipment decreased 57/68/79/29 % US \$ 121 per acre decrease in revenue Death of working age adult: Value of small animals decreased 43 %	Death of male: High value crop area decreased 0.66 acre Conversion from high value crops to low value cereals Death of female head-of-household/spouse: Cereal area decreased 1.2 acre	Sale of small animals/farm equipment Acquire bride dowries Consumption of small animals
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IMPACTS OF SCHISTOSOMIASIS AND MALARIA

Authors Country	Study design	Time allocation and labour use	Cash allocation	Production responses	Other coping responses
Amacher et al. (2004) Ersado (2005) Ersado et al. (2004) Ethiopia	CS	Sick days male/female/children for control (intervention): 7.3/12.6/4.0 (12.6/16.8/2.5) Caretaking days male/female for control (intervention): 0.5/1.0 (1.3/1.1) Workdays hired labour for control (intervention): 5.2 (12.9)	Treatment costs control (intervention): US \$ 1.65 (2.71) ~ 1.3 (2.1) % of total household income Productivity loss (marginal value product of fuel wood collection) male/female for control (intervention):	Reduced probability of eucalyptus planting by 43 (32) % for control (intervention) Higher profitability of agricultural production in intervention areas Adoption of	

(1 region)	Significant decline in labour productivity and labour allocation to off-farm activities	US \$ 4.5 /3.3 (10.8/5.6) ~ 3.4/2.5 (8.0/4.2) % of total household income	productivity-enhancing and resource conserving technologies reduced
	Per one planting-weeding-harvesting season (4-6 months)	Significant increase in health expenditures	
		Less off-farm income (US \$ 1997 rate)	

Audibert (1986)	CS		4.9 % decrease in paddy output per 10 % increase in schistosomiasis prevalence
Cameroon (1 region)			No significant impact on agricultural productivity due to malaria

IMPACTS OF SCHISTOSOMIASIS, MALARIA, LOWER RESPIRATORY INFECTIONS AND DIARRHOEAL DISEASES

Authors Country	Study design	Time allocation and labour use	Cash allocation	Production responses	Other coping responses
Sauerborn et al. (1995)	CS	Sick/caretaking days per episode: 3.5/2.7	Value of days lost (average daily wage for hiring labour): 1 792 F CFA ~ 73 % of total costs		
Burkina Faso		1.9 episodes per month			

(1 region)

Recall 1 month

Treatment costs:
854 F CFA (62 % drugs)

Total costs ~ 6.2 % of total
monthly household
expenditure
