

Scale-up of high impact maternal and child health interventions in Ethiopia: equity, cost and cost-effectiveness

Solomon Tessema Memirie



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Scientific environment

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List of abbreviations

ALRI	Acute Lower Respiratory Infections
ARI	Acute Respiratory Infections
CI	Concentration Indices
DHS	Demographic and Health Survey
EmONC	Emergency Obstetric and Neonatal Care
GDP	Gross Domestic Product
HCs	Health Centers
HEWs	Health Extension Workers
HPs	Health posts
HSDP	Health Sector Development Program
HSTP	Health Sector Transformation Plan
ICER	Incremental Cost-Effectiveness Ratio
KMC	Kangaroo Mother Care
LMIC	lower –middle income country
MCH	Maternal and Child Health
MMR	Maternal Mortality Ratio
MNH	Maternal and Neonatal Health
NHA	National Health Accounts
NMR	Neonatal Mortality Rate
OOP	Out-Of-Pocket
PHC	Primary Health Care
pPRoM	preterm Prelabor Rupture of Membranes
RPR	Rapid Plasma Reagin
SBA	Skilled Birth Attendant
UHC	Universal Health Coverage
WHO	World Health Organization

Definition of terms

Absolute poverty level [§]	Income level below which a minimum nutritionally adequate diet plus essential nonfood requirements is not affordable. The amount of income a person, family, or a group needs to purchase an absolute amount of the basic necessities of life.
Antenatal care	It is a type of preventive care with the goal of providing regular check-ups that allow health care providers to treat and prevent potential health problems throughout the course of the pregnancy while promoting healthy lifestyles that benefit both mother and child.
Bias [§]	Systematic error, for example, recall bias resulting from long recall periods.
Catastrophic health expenditure [£]	Expenditure for medical care that endangers the family's ability to maintain its customary standard of living.
Cost-effectiveness [§]	The net gain in health or reduction in disease burden from a health intervention in relation to the cost.
Determinant [§]	Any factor, whether event, characteristic, or other definable entity, that brings about change in a health condition, or other defined characteristic.
Health inequality	Variations in health status or access to services according to certain attributes such as socioeconomic status, place of residence, race, etc.
Healthy life years [§]	A composite indicator that incorporates mortality and morbidity in a single number.
Impoverishment [^]	Impoverishment in relation to health care payment is when a household that at time of illness diverts expenditure to health care to an extent that its spending on basic necessities falls below the poverty

	threshold.
Inequity in health [*]	Inequalities in health that are systematic, socially produced (and therefore modifiable) and unfair.
Intervention	An intervention is a combination of program elements or strategies designed to produce behavior changes or improve health status among individuals or an entire population.
Neonatal resuscitation [#]	A set of interventions at the time of birth to support the establishment of breathing and circulation.
Out-of-pocket payment	Health care payments made by individuals/households at the point of service delivery that are not tax based and not covered by health insurance.
Poverty line [£]	Poverty line is the monetary cost to a given person, at a given place and time, of a reference level of welfare. People who do not attain that level of welfare are deemed poor, and those who do are not.
Preterm birth	A birth of a baby before 37 completed weeks of gestation.
Prevalence [§]	A measure of occurrence or disease frequency often used to refer to the proportion of individuals in a population who have a disease or condition.
Primary health care ⁺	Primary health care is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individual and families in the community through their full participation and at a cost that the community and country can afford.
Stunting [§]	A measure of protein-energy malnutrition, indicated by low height for age or failure to achieve expected stature.
Under-five mortality [§]	Probability of a newborn dying before attaining the age

of 5 years

Universal health coverage[¶] All people receiving quality health services that meet their needs without being exposed to financial hardship in paying for the services.

[§]Porta M. Dictionary of Epidemiology: Fifth edition. New York: OXFORD UNIVERSITY PRESS, 2008.

[#]Textbook of Neonatal Resuscitation. American Academy of Pediatrics, 5 2006.

[‡]Bekri SE. A look at catastrophic medical expenses and the poor. Health Affairs. 1986; 5, 139-145.

⁺Alma Ata declarations (1978). http://www.euro.who.int/_data/assets/pdf_file/0009/113877/E93944.pdf accessed on 07/04/2016.

[^]O'Donnel et al. [54]. ^{*}Dahlgren et al. [21]. [¶]World Health Organization, 2014 [32].

Abstract

Background: Equity in access to health care services and in health outcome, and safeguarding households from catastrophic and impoverishing medical expenditures are key health systems objectives. However, in low-income countries, studies are lacking that systematically monitor and evaluate health policies with regard to their effect on health inequalities and medical impoverishment. Furthermore, context specific evidence on the cost-effectiveness of interventions is meager. We aim to generate policy relevant evidence on equity, cost and cost-effectiveness of health interventions in order to facilitate priority setting of health interventions in Ethiopia.

Methods: This thesis is based on three studies conducted in Ethiopia. The first study used secondary data from successive demographic health surveys to examine inequalities in maternal and child health (MCH) services in Ethiopia. In the second study, we examined household out-of-pocket (OOP) expenses and impoverishment associated with health care visits for pneumonia and diarrhea in Ethiopia. Data on OOP expenses were collected through exit and follow-up interviews of families who sought care in health facilities. The third study was a contextualized cost-effectiveness analysis (CEA) of maternal and neonatal health interventions scale up in Ethiopia using the World Health Organization's CHOosing Interventions that are Cost-Effective (CHOICE) maternal and neonatal health model.

Results: Between 2005 and 2011, improvements in aggregate coverage have been observed for MCH interventions in Ethiopia. Wealth-related inequality has remained persistently high in all surveys. Socioeconomic factors were the main predictors of differences in MCH services utilization and child health outcome. Utilization of primary care facilities for selected MCH interventions have shown marked pro-poor improvement over the period 2005-2011.

The study on OOP expenses included 345 pneumonia and 341 diarrhea cases. The mean total medical expenditures (in 2013\$USD) per outpatient visit were \$8 for

pneumonia and \$6 for diarrhea while per inpatient care were \$64 for severe pneumonia and \$79 for severe diarrhea. The mean associated direct non-medical expenses (mainly transport costs) were \$2, \$2, \$13, and \$20 respectively. 7% and 6% of the households with a case of severe pneumonia and severe diarrhea respectively were pushed below the extreme poverty threshold of PPP \$1.25 a day. Wealthier and urban households had higher OOP payments but poorer and rural households were more likely to be impoverished due to medical payments.

The CEA showed that all interventions except calcium supplementation (for preeclampsia and eclampsia preventions) were very cost effective with incremental cost effectiveness ratios less than one times GDP per capita. Interventions for newborn care were highly cost-effective (e.g. Kangaroo mother care, neonatal resuscitation, newborn sepsis management, antibiotics for preterm prelabor rupture of membranes) followed by selected antenatal interventions (e.g. tetanus toxoid and syphilis diagnosis and treatment for pregnant women), then followed by more complex interventions that require care at secondary/tertiary level facilities. Delivery of interventions within packages was more cost-effective than delivering single interventions.

Conclusions: Attainment of universal health coverage (UHC) through delivery of quality essential health services package using primary health care (PHC) as the delivery platform is one of the key strategic objectives of the health sector transformation plan for the next five years (2015/2016 – 2019/2020) in Ethiopia. The results of these studies could be used to repopulate the essential health care package in Ethiopia.

Keywords: inequality, maternal and child health intervention, primary health care, out-of-pocket payments, catastrophic health expenditure, impoverishment, pneumonia, diarrhea, cost-effectiveness analysis, Ethiopia

List of publications

The thesis is based on the following three papers, referred to in the text by their Roman numerals:

- I. Memirie ST, Verguet S, Norheim OF, Levin C, Johansson KJ. Inequalities in Utilization of Maternal and Child health services in Ethiopia: the role of primary health care. *BMC Health Service Research* 2016; 16:51. DOI 10.1186/s12913-016-1296-7.
- II. Memirie ST, Metaferia ZS, Norheim OF, Levin C, Verguet S, Johansson KJ. Household expenditures on pneumonia and diarrhea treatment in Ethiopia: a facility-based study. *Tropical Medicine and International Health*. Under review.
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Health is of special moral importance because it contributes to the range of exercisable or effective opportunities open to us. Maintaining normal functioning through public health and medical interventions thus makes a limited but significant contribution to the range of exercisable opportunities open to people.

NORMAN DANIELS

1. Introduction

1.1. Background

Ethiopia is situated in the Eastern part of Africa commonly recognized as The Horn of Africa. The land area of Ethiopia is approximately 1.1 million square kilometers. The population of Ethiopia in 2007 was estimated at 74 million. The projected population in 2013 based on the 2007 national census was 94 million, making the nation the second most populous country in Africa [1]. The majority of the Ethiopian population lives in rural areas (84 %) and the population pyramid remain quite young: 44 % are under 15 years [2]. The average household size is about 4.7.

At present Ethiopia is administratively structured into nine national regional states - Oromia, Amhara, Southern Nations Nationalities and People Region (SNNPR), Tigray, Benishangul-Gumuz, Gambella, Afar, Somali, and Harari - and two city administrations, that is, Addis Ababa City Administration and Dire Dawa City Council. Ethiopia is a blend of diverse customs and cultures that embraces a complex variety of nationalities, peoples, and linguistic groups. Its peoples altogether speak over 80 different languages [3].



Figure 1: Map of Ethiopia with administrative regions (Source: web¹)

In spite of rapid economic development in the last decade, at an average annual growth rate of 11% per year, Ethiopia remains one of the poorest countries in Africa with annual per capita earnings of about US\$ 550, which is well below the sub-Saharan African average of US\$1640 [4, 5]. It is estimated that 31% of the population live below the absolute poverty line [6].

Ethiopia had endorsed a Health Sector Development Plan (HSDP) which focused on prevention and mitigation of priority health problems such as HIV/AIDS, tuberculosis, malaria, diarrheal diseases and common childhood and maternal illnesses. Since 1997/98, four cycles of HSDPs were developed and implemented [7].

¹ Ethiopia administrative divisions. http://www.123rf.com/photo_38368903_stock-vector-ethiopia-administrative-divisions.html accessed on 07/04/2016.

One of the focus areas of the HSDPs was an accelerated expansion of primary health care (PHC) facilities (composed of health centers and health posts) that was commenced in 2003. In nearly a decade, the number of health posts and health centers in Ethiopia grew by almost six fold to reach 3245 health centers and 16,048 health posts in 2012/2013. Each health post has two health extension workers and so far a total of 34,850 health extension workers were trained and deployed nationally with a ratio to population of 1:2300 that surpassed HSDP III target of 1:2500 [7, 8]. The PHC service in Ethiopia is organized to deliver a package of basic preventive and curative health services targeting rural households. It is comprised of the following four health subprograms that conform to the elements of PHC as defined in the Alma Ata Declaration [9]: hygiene and environmental sanitation, disease prevention and control, health education and communication and family health (that include maternal and child health, vaccination and family planning services). The expansion is envisaged as the key strategy to deliver maternal, neonatal and child health interventions especially to the rural and impoverished segments of the population [10].

The rapid expansion of healthcare facilities has contributed to improved access to health care services in Ethiopia. According to successive demographic and health surveys (DHS) conducted in Ethiopia [11-13], the percentage of women who received antenatal care (ANC) from a trained health professional at least once for their last birth has increased from 27% in 2000 to 34% in 2011. Use of modern contraceptive methods among currently married women has increased from 6% in 2000 to 27% in 2011. The percentage of children immunized for measles has increased from 21% in 2000 to 56% in 2011. Similarly, among children who had diarrhea, 22% in 2005 and 32% in 2011 were taken for advice or treatment to a health facility or provider.

Albeit gradual improvements in coverage of maternal and child health care services, inequality in access to care between urban and rural dwellers, among regional states, and across wealth quintiles remain large. Among households with a child having either symptoms of pneumonia or diarrhea; 16% and 22% of households from the

poorest quintile and 62% and 53% from the richest quintile sought care from a health care provider, respectively (Figure 2). The low service utilization occurred in the face of an increased risk of diarrhea and pneumonia among children from the poorest quintile [13]. Likewise, 75% of women from richest quintile had ANC while only 17% of women from poorest quintile did so. Similar disparities were also observed by place of residence, where urban residents had much higher service utilization than their rural counterparts. Such disparities were also observed for other services and by region [13].

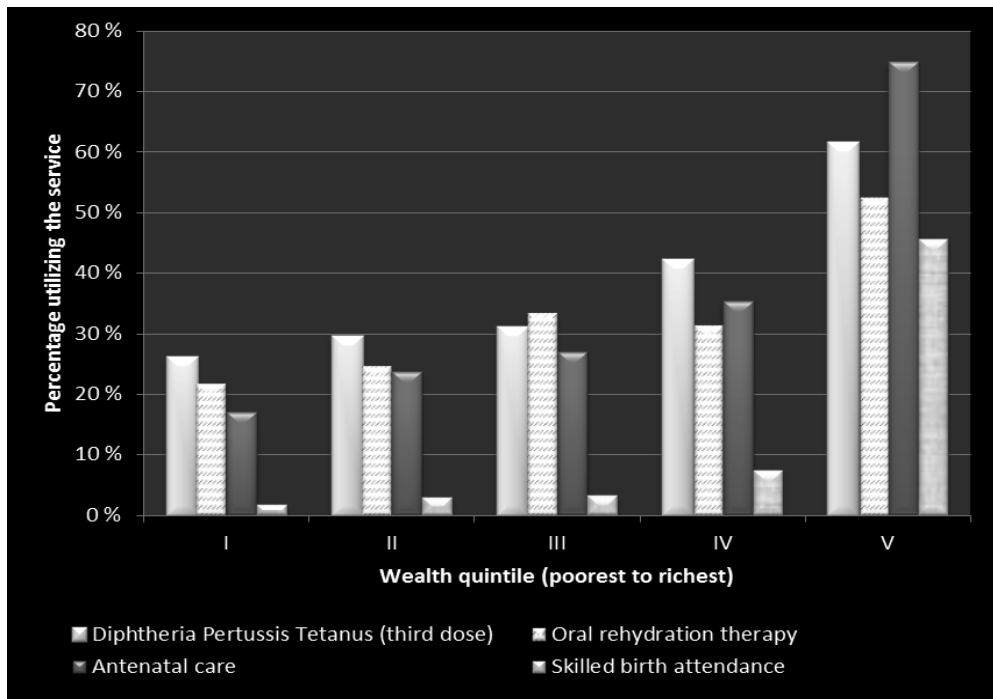


Figure 2: Distribution of maternal child health interventions, by wealth quintile in Ethiopia (DHS 2011).

Consistent with a better access to care, the health status of the populations has shown remarkable improvement, notably in maternal and child health. Infant mortality rate decreased from 77 in 2005 to 59 deaths per 1,000 births in 2011 [12, 13]. Similarly, under-five mortality has decreased from 123 to 88 per 1,000 births. Under-five

stunting rate has declined from 58% in 2000 to 44% in 2011 [11, 13]. Vital health indicators from the 2005 DHS show a life expectancy at birth of 53.4 years for males and 55.4 for females. Life expectancy at birth increased in Ethiopia to 65 for females and 62 for males in 2013 [14]. Parallel to access to health services, health status improvements were also unequally distributed in Ethiopia. The improvement in health status disproportionately favors urban residents and wealthier quintiles. According to Ethiopia's 2011 DHS, infant mortality is 29% higher in rural areas than in urban areas. The urban-rural difference is even more pronounced for mortality in children under five years of age, and up to 37% higher in rural areas than in urban areas. The poorest and the richest quintiles had an under-five mortality of 137 and 86 deaths per 1,000 live births, respectively. Furthermore, wide regional variations are observed in mortality rates in infants and children, with more than a twofold difference, for example, between Addis Ababa and Benishangul-Gumuz in the western part of the country [13].

Irrespective of the improvements in access to care and health status of the Ethiopian population over the last decade far remains to be done along the path to universal health coverage (UHC). Acknowledging the challenges in access to health care in general and the inequality in particular, the Federal Ministry of health of Ethiopia has launched a Health Sector Transformation Plan (HSTP) in 2015 [15]. The HSTP is the first phase of a 20-year plan titled, 'Envisioning Ethiopia's Path to Universal Health Care through strengthening of Primary Health Care'. The core purpose of the visioning exercise is to promote health and wellbeing of Ethiopians through providing and regulating a comprehensive package of promotive, preventive, curative and rehabilitative health services of the highest possible quality in an equitable manner that serve the priority health needs of the majority of its people. Furthermore it tries to develop a system that will be sustainable, adaptive and efficient to satisfy the evolving health needs of the population between now and 2035. It is anticipated that in the coming 20 years, Ethiopia will continue its fast pace of development, and aim to transition into a lower-middle income country by 2025 and a middle-middle income country by 2035.

According to the 2010 World Health Report, on the path to UHC, countries should address all the following three dimensions: extend coverage to more people, offer more services, and/or pay a greater part of the cost [16]. Ensuring financial risk protection is one of the health sector's objectives that is explicitly described on the national health policy of Ethiopia [17]. This is also among the strategic objectives in the HSTP, that also strives to improve equitable access to a full spectrum of essential, quality health services.

The exercise of health services prioritization for scale up in the HSTP document was mainly based on disease burden and availability of effective interventions. Cost-effectiveness of an intervention was not a key issue in priority setting in the HSTP. Rather, other modalities of efficiency gains were given due emphasis that includes: proper allocation, efficient utilization, tracking and controlling of resources; harmonization and alignment among stakeholders to strengthen the financial and procurement management system of the government, to minimize wastage of resources and duplication of efforts.

Recognizing the importance of local evidence on cost-effectiveness of interventions for decision-making, and the need for capacity building, the Federal Ministry of Health of Ethiopia has recently committed to establish a Health Economics and Financing Unit under the Financial Resource Mobilization Division. The unit is expected to play a pivotal role in identifying knowledge gaps, in prioritizing research needs, and in providing guidance to the Federal Ministry of Health with relevant evidence for policymaking.

1.2. Why inequity in health matters?

As was described earlier there is marked variation in access to health care and health outcomes across different socioeconomic groups, among regional states and by place of residence (urban vs. rural) in Ethiopia. It has been long known that inequalities in income do produce inequalities in health with richer people generally enjoying better

health than poorer individuals [18]. In many developing countries determinants of population health are not limited to socioeconomic status but also include geographic location, gender, religion and other factors. Anand described two important reasons for investigating inter-group inequalities in health [19]; first, to identify groups at high risk or groups that suffer particularly poor health. Such inter-group inequalities in health are more likely associated with social causes rather than natural factors suggesting social determinants of health. Second, public policy and public health policy may thus be able to target them directly in order to improve their health. Daniels et al, in their paper “Justice is good for our health” highlighted the importance of improving social conditions, apart from the traditional focus on the health sector, to ensure greater equity in health [20].

In the analysis of individual or group health variations it is important to differentiate systematic variations from genetic, constitutional or random variations. Women in Ethiopia, as is the case in many other countries, have a higher life expectancy at birth than men which is more likely to be biological than social. Similarly, older age groups tend to be sicker than younger age groups because of the natural aging process. Are all health variations between groups inequitable? According to Whitehead and Dahlgren, combinations of three distinguishing features turn mere variations or differences in health into a social inequity in health. These are: health inequalities that are systematic, socially produced (and therefore modifiable) and unfair [21].

The first feature is the systematic pattern of the differences in health rather than being randomly distributed. An illustrative example is the differences in health among different socioeconomic groups. The second feature is the social processes that produce health differences, instead of having biologic roots. Poor families in many countries lack access to clean water, sanitation, adequate shelter, basic education, vaccinations, and prenatal and maternal care. As a result of some, or all, of these factors, under-five mortality rates for the poor exceed those of the rich. Since social

policies could supply the missing determinants of child health, these disparities are modifiable [22].

Before discussing why inequity in health matters, let us look at why health is important in the first place. Health as a special good has long been recognized. Health is regarded to be critical because it directly affects a person's wellbeing and is a prerequisite to human functioning as an agent. In the words of Amartya Sen, health contributes to a person's basic capability to function—to choose the life she has reason to value [23]. Health is also a unique resource for realizing other objectives in life, such as better education and employment. Health has both intrinsic and instrumental value.

Inequities in health are thus closely tied to inequalities in the most basic freedoms and opportunities that people can enjoy. Therefore, we can infer that inequities in health constitute inequalities in people's capability to function. Impairments to health constrain what people can do or be and result in a denial of equality of opportunity. The principle of "fair equality of opportunity" is one of three principles of John Rawls's "justice as fairness" [24]. Even though the discourse by John Rawls was not directly related to health, Norman Daniels extended the principle to deal with fair access to health care. In his book *Just Health: Meeting Health Needs Fairly*, he emphasized the importance for a society to organize its health resources equitably, so that access to those resources is open to everybody. The existence of clear social differentials in population health that result from an unjust distribution of the socially controllable factors goes against accepted values of fairness and justice [25].

1.3. Priority setting and cost-effectiveness analysis

The primary objectives of health systems are to improve access to services and to distribute health services fairly thereby improve population health. Universal health coverage is a powerful tool to this end [26]. On the path to UHC, countries are required to progressively expand a comprehensive range of key services. At each point on this path, it is important to ensure an appropriate mix of services. In

selecting services for scale-up, countries are required to select and expand coverage of priority health interventions. The choices of health interventions for scale in a country could positively or negatively affect some people in the population it serves. Therefore, decision makers should justify their decisions to all stakeholders and be able to demonstrate that their decisions are aligned with the country's social values concerning health maximization, health distribution, and financial risk protection [27].

Countries use different sets of criteria for selecting priority interventions for scale-up. Some countries have explicit criteria for priority setting while many lack explicit criteria [28, 29]. Many national and international guidelines for priority setting give due weight to the cost-effectiveness of an intervention [28-30]. Cost-effectiveness analysis (CEA) identifies services that generate large total benefits relative to cost. Priority setting based solely on CEA may maximize population health but will not address the full range of health system objectives such as equitable health distribution and financial risk protection [31].

The WHO Consultative group on equity and UHC recommends that countries should consider the following three criteria during priority setting of health services: cost-effectiveness of interventions, priority to worst off and financial risk protection [32].

1.3.1. Priority to cost-effective services

Because of steep increases in health interventions costs and budget constraints in many countries, cost-effectiveness of health interventions has become a central guiding principle in priority setting [33]. The basis of such decisions is that interventions should not only be effective, but also worth their costs [33]. Prioritizing services in order of their cost-effectiveness would then maximize population health benefits for a given budget (best value for money). Many economists and ethicists support cost-effectiveness because the opportunity costs and the size of health benefits are too high and would be unethical to ignore [34].

Prioritizing health interventions based solely on cost-effectiveness may not always be aligned with the public view of fair health care distribution. A good example is the Oregon process of ranking of condition treatment pairs and subsequently the services that would be covered by Medicaid by their relative cost-effectiveness [28]. This method was abandoned because of public outcry over the resulting ranking of services. An important lesson learned from the process was that the public did not accept a straightforward health-maximizing strategy [25]. Further research in the field later confirmed the view that many people in various cultures were not purely health maximizers [35]. Therefore, in the decision to fund one intervention and refuse to fund another, decision-makers should carefully consider equity criteria alongside the results from cost-effectiveness analyses.

The results of cost-effectiveness analysis could serve as a basis for priority setting with consideration of other social objectives such as priority to the worst off and financial risk protection. There are some international efforts to avail results of economic evaluations of health interventions in developing countries. The World Bank and the World Health Organization promoted the role of economic evaluation of health interventions in developing countries [36, 37]. However, the use and application of CEA information to guide the priority-setting process of national governments remains rather limited [38]. Hutubessy et al. suggested a number of potential reasons why national governments were not able to use CEA information that included: political expediency, social preferences and systemic barriers to implementation [38]. Furthermore, data unavailability, methodological inconsistency of economic evaluations, and the limited generalizability or transferability of findings to settings beyond the location of the original study were additional reasons for not using CEA information in developing countries [39, 40]. In the face off huge variation in the cost-effectiveness of interventions across services, the cost-effectiveness criterion, even if imperfect—in addition to other relevant criteria that address societal preferences—is likely to be better in priority setting of health interventions than ignoring cost-effectiveness entirely [32].

1.3.2. Priority to the worst off

Decisions based on CEA are solely concerned with maximizing the health benefit (for example, healthy life years gained) of the population, irrespective of whom those health benefits go to and how they are distributed across society. Empirical evidence from a range of countries suggests that people are willing to sacrifice gains in life years in order to give priority to the most severely ill [41, 42]. Equity concerns were explicitly included in priority setting efforts in Norway, Sweden, the Netherlands and Denmark where the following criteria were considered: severity, necessity (need), social and geographical equity [28, 43]. Equity considerations require that more weight be given to health gains in the severely ill or the worst off.

A central question that follows is who are the “worst off”? There are many, yet partly overlapping concepts related to characterization of the worst off. These include reasons related to equality, compassion, humanitarianism and a concern for greater relative improvements [44]. Here we discuss two important approaches, fair innings and prospective lifetime. Prospective lifetime approach prioritizes patients who are closest to death, disregarding any differences in patients’ age [45]. The idea is compatible to the claim that society is obliged to do everything possible to salvage all individuals facing immediate threats to life and/or health [46]. Allocations based on this principle ignores prognosis of individuals after an intervention, and it applies even when only small gains at a relatively high cost can be achieved. Furthermore, in the face of scarce resources, rescuing all individuals in need may not be possible, and rescuing one person may mean that other people cannot be rescued which is inconsistent with the core idea of priority to the worst off [47].

The fair innings approach on the other hand is based on the assumption that everyone is entitled to some ‘normal’ span of life or health achievement. Anyone failing to achieve this has in some sense been disadvantaged in terms of lifetime health therefore is worst off, while anyone getting more than this is living on ‘borrowed time’ [48]. Based on this principle, health gains in people who have had their fair innings would be valued lower than health gains in people who are expected to get

less than their fair innings. Equity weights based on fair innings will result in higher health gains in relatively younger persons than those who are older. In their publication “Principles for allocation of scarce medical resources”, Emanuel et al [47] state that

“Prioritizing the youngest gives priority to the worst-off —those who would otherwise die having had the fewest life-years—and is thus fundamentally different from favoritism towards adults or people who are well-off. Also, allocating preferentially to the young has an appeal that favoring other worst-off individuals such as women, poor people, or minorities lacks: Because [all people] age, treating people of different ages differently does not mean that we are treating persons unequally”.

Resource allocations based on a strict fair innings principle directs scarce resources predominantly to infants, an approach that may not always be correct. The death of a productive young woman is intuitively worse than the death of an infant, even though the infant has had less life [47]. The young woman has her own developed personality as opposed to the infant, and has drawn upon the investment of others to begin as-yet-unfulfilled projects. Furthermore, allocations based on fair innings principles tend to ignore prognosis untreated and exclude older people [48]. Despite some of the limitations, there seems to be much preference for the principle of fair innings where the public was significantly more concerned about reducing inequalities in total lifetime than it was in reducing inequalities in prospective lifetime [45, 49].

In conclusion, both the fair innings and prospective lifetime principle seem to be insufficient on their own, but they could be combined together (and with other criteria, for example, CEA and financial risk protection) in the process of context specific health services priority setting [43]. Incorporating equity weights in priority setting decisions is likely to improve its acceptance by the public.

1.3.3. Priority to services whose coverage offers substantial financial risk protection

Direct payments for health care can have negative consequences for families, including pushing families into poverty or further into deeper poverty. Financial risk protection is one of the central themes on the path to UHC [16]. On the path towards UHC, countries must expand access to quality health services and reduce out-of-pocket payments at the point of health service delivery. Therefore, in the selection of intervention mix for scale-up, inclusion of services that offers substantial financial risk protection should be given due consideration along with other priority setting criteria.

Evidence that integrate health gains and financial risk protection and distributional considerations in economic evaluations is emerging as an extension of the traditional CEA (referred as “extended cost-effectiveness analysis”) [50-52]. This approach is useful in assessing the potential impact of universal public financing (full public finance irrespective of whether services are provided privately or publicly) of preventive and curative interventions on health gains and financial risk protection afforded to households. The results of such exercise will enable policymakers to consider multiple benefit streams when considering public finance of health interventions.

Services that are costly are highly likely to result in financial hardship for households than low cost services. High cost services are also more likely to be less cost-effective and on the contrary, less costly services can be highly cost-effective, complicating the tradeoff between financial risk protection and interventions cost-effectiveness. Universal public financing of services that offer substantial financial risk protection may result in health benefits that are far less than what could be gained from low-cost services [52]. However, this is not always true especially in resource-poor settings, where out-of-pocket payments related to low-cost services such as treatment of pneumonia and diarrhea may result in financial hardship and impoverishment [53]. In such contexts, scaling-up coverage for low-cost high priority services may also offer a significant financial risk protection.

In the preceding narrative we have tried to discuss why inequality/inequity in health matters and core aspects of health care priority setting, that are: cost-effectiveness of interventions, priority to worst off and financial risk protection (though these are not the only consideration in priority setting of health interventions). The first paper, in our series, deals with inequalities/inequities in utilization of maternal and child health services and child health outcomes in Ethiopia. The second paper addresses household out-of-pocket payments for the treatment of pneumonia and diarrhea in Ethiopia and impoverishment associated with such payments. The third deals with cost-effectiveness analysis of 13 single and 2 packages of maternal and neonatal health interventions in Ethiopia. The evidence presented in this thesis is well aligned with the priorities of the Federal Ministry of Health in Ethiopia. The studies are expected to feed into the policy decision process of health services prioritization in Ethiopia and facilitate the countries endeavor to avail a comprehensive set of priority health interventions accessible to all the population.

2. Aims

The general aims of this thesis are to assess the distribution of access to care among different population groups, quantify household out-of-pocket expenditure and related impoverishment and analyze the cost-effectiveness of scaling up maternal and child health interventions in Ethiopia. The ultimate objective is to generate policy relevant evidence on equity, cost and cost-effectiveness of health interventions in order to facilitate the priority setting process in Ethiopia.

Specifically, the aims are

Paper 1:

- to measure changes in the degree of inequality in utilization of selected MCH interventions and child morbidities over time;
- to determine factors associated with inequality and inequity in access to care; and
- to assess the role of expansion of PHC facilities in Ethiopia on inequality and inequity in access to care using the 2005 to 2011 demographic and health surveys (DHS) conducted in Ethiopia.

Paper 2:

- to estimate and characterize household out-of-pocket (OOP) costs associated with an episode of childhood diarrhea and pneumonia by type and level of care;
- to assess the extent to which OOP costs for diarrhea and pneumonia contribute to impoverishment of the household; and
- to examine the distribution of household OOP costs across wealth quintiles and by place of residence.

Paper 3:

- to examine the cost-effectiveness of selected maternal and neonatal health interventions in an Ethiopian setting.

3. Materials and methods

3.1. General design

The studies in this thesis were conducted using multiple approaches. Paper I deals with secondary data analysis using successive demographic health surveys conducted in Ethiopia. Paper II is a facility-based cross sectional survey of household out-of-pocket expenditures for the treatment of pneumonia and diarrhea in children under five years of age. The study employs a mix of retrospective and prospective primary household data collection for medical and household consumption expenditures. Paper III is a contextualized cost-effectiveness analysis of maternal and neonatal health interventions scale up in Ethiopia using the World Health Organization's CHOosing Interventions that are Cost-Effective (CHOICE) maternal and neonatal health model. The analysis included 13 single and 2 packages of maternal and neonatal interventions of proven efficacy.

3.2. Inequalities in utilization of maternal and child health services - Paper I

The study was based on secondary data from DHS conducted in Ethiopia in 2005 and 2011 [12, 13]. The 2005 and 2011 DHS were conducted on a nationally representative sample of 9,861 and 11,654 households, respectively. The survey participants/households were stratified into urban or rural groups according to their area of residence. Household's socioeconomic status was measured using household asset data via a principal components analysis. We used the wealth quintiles as a living standard measure in the subsequent modeling. Utilization of MCH services was selected for analysis. We included both preventive and curative services such as medical treatment for diarrhea, skilled birth attendance (SBA), measles immunizations and modern contraceptive usage. Additionally, prevalence of diarrhea, cough, fever and stunting in children were selected as morbidity variables.

We used the concentration index to measure wealth-related inequality in a health variable (be it a health outcome or utilization). This was followed by decomposition

of the concentration index to assess the contribution of different factors to the inequality in the health variable of interest – the contributions from education inequalities, income inequalities, and area of residence (urban vs. rural). Only 0.5% of the households in Ethiopia had health insurance coverage, therefore we did not use it as one of the contributory factors for the differences in health care utilization among households [13].

The poor may use health services less, despite having higher levels of need. These inequalities reflect mainly differences in income, living conditions, educational status, and so on – rather than differences in preferences, and therefore qualify as health inequities. In order to measure health inequities, the concentration index has to be standardized for differences in need among different population groups. We used the indirect standardization approach to adjust for differences in need (difference in age, sex, morbidity, etc. among different socioeconomic groups). Indirect standardization makes “corrections” to the actual distribution by following two steps: First it computes the population mean of the need standardizing variable, then adjusts the distribution of the health variable of interest by comparing it with the distribution that result from the mean effects of the need-standardizing variable. For decomposition of the concentration indices as well as for need standardization we used a linear regression model.

Time trends for changes in mean levels of MCH service utilization were assessed using a logistic regression model. MCH service utilizations were used as dependent variables with time of survey as independent variables. We chose the logistic regression model over the chi square test for trend for the reason described below. We compared the logistic regression model and chi square test for trend (“nptrend” command downloaded from Stata version 13) for their outputs. The logistic regression model without weighting and the chi square test for trend resulted in almost identical z-scores and p-values. Applying weight to the logistic regression model has a different output with lesser z-scores. As it was not possible to apply weight to the “nptrend” command, we used the logistic regression model with

weighting in our analysis. We deemed the difference in concentration indices between 2005 and 2011 values to be significant based on a non-overlapping 95% confidence interval that was cross checked through plotting the concentration curves for both 2005 and 2011 on one graph (a non-overlapping curve). Further details of the study methods are provided in Paper I.

3.3. Pneumonia and diarrhea treatment expenditures in Ethiopia – Paper II

The household cost study was carried out in four major regions (Oromia, Amhara, SNNP and Tigray) and Addis Ababa city administration (the capital city) in Ethiopia. Data were collected from individuals seeking services from a sample of 6 public hospitals, 15 public health centers, 9 health posts and 5 private health facilities through exit interviews using a structured questionnaire (Figure 3).

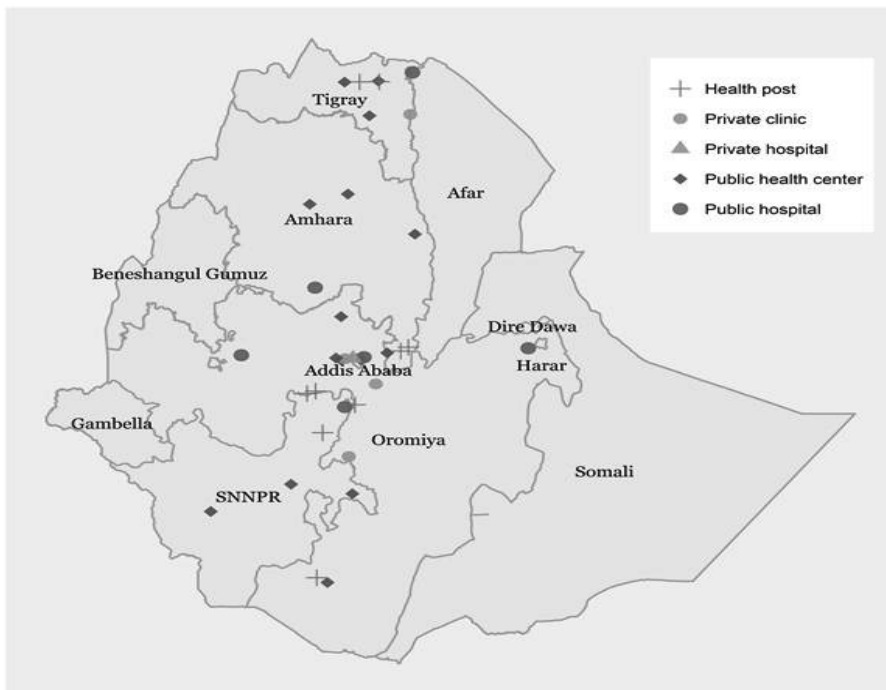
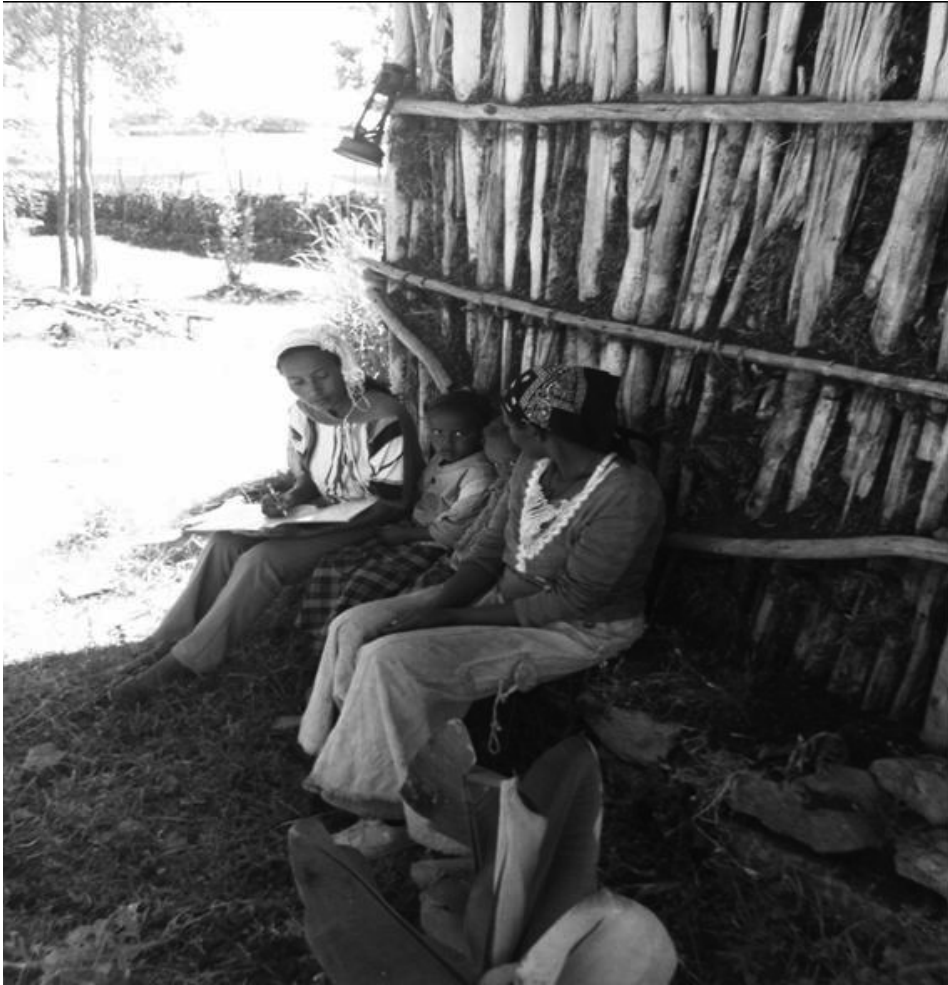


Figure 3: Distribution of health facilities included in the study

We collected data from parents or caregivers of children 0–59 months of age with a clinical diagnosis of pneumonia (345 patients) or diarrhea (341 patients) but without other illnesses. Data on direct medical expenses (registration, diagnostic work-up, medications, and hospital bed), direct nonmedical expenses (transportation, food and drinks, lodging, etc.) and parents' time loss were collected when families exited health facilities. Furthermore, parents were asked whether they had used over-the-counter medications and/or had a visit to traditional healers before visiting the formal private or public sector. In order to ascertain recovery and estimate additional costs, a prospective follow-up interview was conducted at the household level within two weeks of initial interview or discharge. We used a two-week time interval since both pneumonia and diarrhea episodes are usually acute and were likely to be resolved in the period. We collected data on expenditures related to food items (including consumptions from home productions, food received as gifts or remittances and food received as in-kind payments), nonfood, nondurable items, consumer durables and housing with a recall period of one month. We derived an estimate of annual household consumption expenditures based on the monthly survey data. We imputed the value of non-purchased food by using the quantity of food consumed and estimates of “farm-gate” prices. Among the consumer durable items, we only used rent paid for housing in our analysis because data on the type and date of purchase of consumer durables were not available. For households that do not report rent, we imputed a value by using the relationship between rent and housing characteristics (through a regression analysis) in the subset of households that reported rent [54]. This was done for each region separately because of variations in rent among different regions.



Data collection at household level

Caretakers' time loss was estimated by adding the time spent seeking health care prior to outpatient consultation and/or admission and the duration of outpatient and/or inpatient stay. Data was collected after getting written consent from each interviewed parent or legal guardian (Appendix V).



A supervisor on a field visit

To obtain direct medical treatment expenses per case, we added up the OOP payments associated with registration, diagnostic work-up, medications and hospital stay. Similarly, direct nonmedical expenses of treatment per case were calculated by summing the OOP payments for transportation, food, lodging and other costs incurred in relation to treatment services sought and received. Total OOP expenditure per case was calculated as the sum of the direct medical and nonmedical expenses. We did not estimate the economic value of productivity losses associated with caregiver's transport and health seeking time. The two accepted approaches to value time loss (human capital and friction cost approaches) use gross wages, which is less meaningful in an economy that is largely subsistence [55].

We also examined how household economic status, type of health facility visited, region of the health facility, and geographic locations (urban vs. rural) were associated with the costs incurred by households. We used a linear regression model to predict differences in mean household treatment costs by type of illness. P-values of 0.05 or lower were deemed to be significant.

Catastrophic health expenditures (CHE) to households associated with health care OOP expenses for pneumonia or diarrhea was calculated by computing OOP expenditure incurred minus any reimbursements from third-party payers divided by annual household nonfood expenditure (capacity to pay- defined as effective income net of subsistence spending), following the WHO definition of CHE [56]. More specifically, we defined capacity to pay (nonfood expenditure) as total household expenditure net of food spending. One can better distinguish between the rich and the poor by using nonfood expenditures than total expenditure. Additionally, CHE was calculated using total annual household expenditure as the denominator.

We measured both the incidence (catastrophic payment head count) and intensity (the average degree by which payments as a proportion of total expenditure or nonfood expenditure exceed a specified threshold [54]) of catastrophic payments. The measurement of these parameters is as follows: let P be out-of-pocket health care payment, x be total household expenditure, and y be food expenditure, therefore $x-y$ is the capacity to pay. Then, a household is said to have incurred catastrophic payments if P/x , or $P/(x-y)$, exceeds a specified threshold, z . The threshold represents the point at which families will have severe disruptions to their living standards due to health care spending. There is no exact consensus about the critical threshold level, therefore we opted to do the analysis and present the results of CHE at various threshold budget shares of capacity to pay and total household expenditure.

To measure catastrophic head count in relation to total household expenditure and capacity to pay, respectively, let us define an indicator T , which equals 1 if $P_i/x_i > z$ or

$P_i/(x_i-y_i) > z$ and zero otherwise. Then an estimate of the catastrophic head count (H) is given by

$$H = \frac{1}{N} \sum_{i=1}^N T_i,$$

where N is the sample size.

To measure intensity of catastrophic payments in relation to total household expenditure and capacity to pay, respectively, first we defined catastrophic overshoot as $O_i = T_i((P_i/x_i)-z)$ or $O_i = T_i[(P_i/(x_i-y_i))-z]$, then the average overshoot is calculated as:

$$O = \frac{1}{N} \sum_{i=1}^N O_i.$$

Incidence and intensity of catastrophic health payments are related through the mean positive overshoot (MPO), which is defined as follows:

$$MPO = \frac{O}{H}.$$

The relationship between incidence and intensity of catastrophic health payments is demonstrated in Figure 4 below. The horizontal axis shows the cumulative share of the sample, ordered by the ratio P/x , beginning with individuals with the largest ratio. Level of intensity of catastrophic health payment (O) is shown by the area that is above the threshold level (horizontal line) and under the payment share curve. The catastrophic head count is the point where the payment share curve intersects the horizontal line (threshold level).

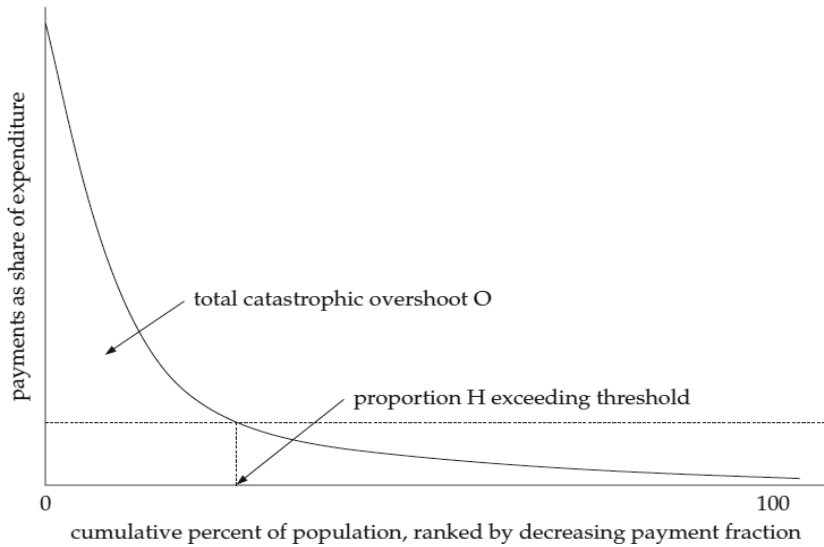


Figure 4: Showing the relationship between intensity and incidence of catastrophic health payments. Source: O’Donnell et al. [54].

Medical impoverishment was measured as the expected number of households that fell below the poverty threshold of \$1.25 due to OOP spending on health care. Methodologically, assessment of catastrophic and impoverishing health payments share many similarities. Poverty is measured using two basic parameters: the head count and the poverty gap. Poverty head count is the fraction of people living in poverty (fraction below the poverty line). The poverty gap measures the “depth” of poverty, that is, the amount of money by which the poor households fails to reach the poverty line (PL). Computation of poverty measures is as follows: let w_i be the per capita consumption expenditure of household i . An estimate of the poverty head count ratio without health payment deduction is

$$H^{gross} = \frac{\sum_{i=1}^N n_i P_i^{gross}}{\sum_{i=1}^N n_i},$$

where $P_i^{gross} = 1$ if $w_i < PL$ and is 0 otherwise, n_i is the number of individuals in the household, and N is the number of households in the sample. Then P_i^{net} (the poverty head count after deducting health care payment from the per capita consumption expenditure) is computed as, $P_i^{net} = 1$ if $(w_i - P_i) < PL$ and is 0 otherwise.

To measure mean poverty gap (G^{gross}), first define the individual level poverty gap by $g_i^{gross} = P_i^{gross} - w_i$ followed by the mean of this gap in currency units

$$G^{gross} = \frac{\sum_{i=1}^N n_i g_i^{gross}}{\sum_{i=1}^N n_i}.$$

The net of health payments poverty gap is $g_i^{net} = P_i^{net} - (w_i - P_i)$.

Different countries may use different poverty lines in the assessment of the poverty impact of health care payments. In such circumstances, it is important to normalize the poverty gap on the poverty line as follows:

$$NG^{gross} = \frac{G^{gross}}{PL}.$$

3.4. Cost-effectiveness analysis of maternal and neonatal interventions – Paper III

We conducted a generalized CEA in an Ethiopian setting using the World Health Organization's Choosing Interventions that are Cost Effective (WHO-CHOICE) maternal and neonatal health model [57]. Unlike traditional cost-effectiveness studies that compare prospective new interventions to current practice, generalized CEA assumes a broader sectoral view. The method compares the incremental cost and effectiveness of an intervention scale up with the counterfactual (do nothing or null), where it is assumed that all the current intervention mixes ceased to exist starting today. It enables comparison of a wide range of preventive, curative and rehabilitative interventions that have implications for the optimal mix of interventions and therefore result in the highest possible overall level of population health [58]. It allows reallocation of resources from cost-ineffective interventions to cost-effective ones that enhances the allocative efficiency of the health sector [59].

Our analysis included 13 single and 2 combinations of interventions that are provided during pregnancy, childbirth and the neonatal period (Paper III, Table 1A). Efficacy data was based on a recent update by the Child Health Reference Group for maternal and neonatal health for the Lives Saved Tool [60-71]. Quantities of resource inputs

were based on WHO guidelines. Prices were updated from Ethiopia's Ministry of Health and WHO country office most recent data base. For drugs and supplies, we used the lowest "supplier" prices available internationally [72-73]. We reported the outcome as the cost per healthy life years gained in year 2011 US dollars. The health benefits were reported in healthy life years gained that are discounted (as recommended by WHO-CHOICE) at a rate of 3% per year, but not age weighted. Similarly, future costs were discounted to 2011 values using a 3% discount rate per year.

Given the uncertainty surrounding costs and effectiveness of interventions, we conducted a probabilistic sensitivity analysis with Monte Carlo simulations where cost and effectiveness values were varied by 15-25% [74]. Additionally, information on level of adherence for the conditions included in our analysis was lacking. Therefore, we conducted a sensitivity analysis by varying the level of adherence. Further details of the study methods are provided in Paper III.

Ethical considerations

The project was approved by Regional committees for medical and health research ethics in Norway and Ethiopian Health and Nutrition Research Institute scientific and ethical review committee.

4. Results

4.1. Inequalities in utilization of maternal and child health services

Utilization of maternal and child health services has on average increased between 2005 and 2011. Measles immunization coverage improved from 35% in 2005 to 56% in 2011. Skilled birth attendance and usage of modern family planning methods (here the denominator is all women, not among currently married women, which was used in the introductory section) also showed improvement from 6% and 17% in 2005 to 10% and 19% in 2011, respectively. Pro-poor coverage changes with a clear dominance were observed for measles immunization and modern contraceptive methods, demonstrated by significantly (non-overlapping 95% CI) lower concentration indices in 2011 as compared to 2005. Figure 5 below demonstrates the pro-poor improvement in utilization of measles immunization in 2011 as compared to 2005 using concentration curves. The figure shows that the 2011 curve lies all over above the 2005 curve without any overlap.

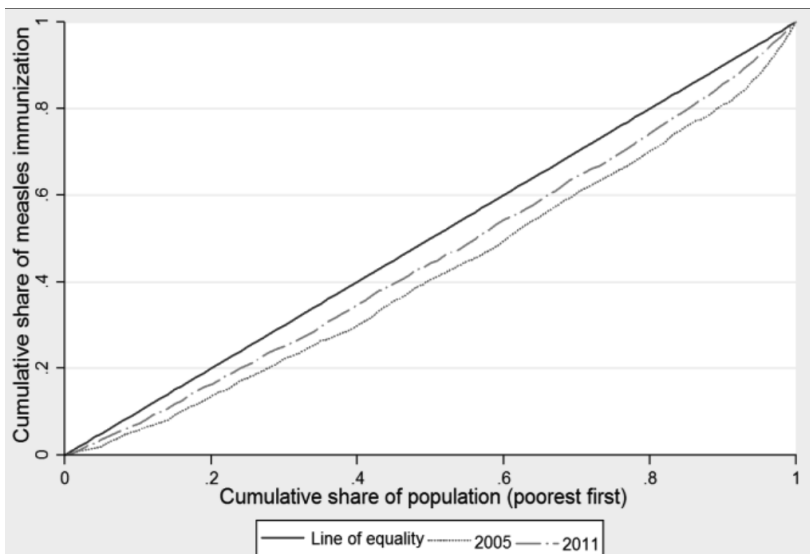


Figure 5: Concentration curves for coverage of measles immunization in Ethiopia, 2005 and 2011.

Skilled birth attendance and use of modern contraceptive methods had the widest coverage gaps between the poorest and wealthiest in all surveys. In 2011, skilled birth attendance and modern contraceptive methods use rates were 2% and 6% for the poorest quintile and 46% and 44% for the wealthiest quintile, respectively. All quintiles (quintiles I-IV) except the wealthiest had skilled birth attendance rates of less than 8%. This is demonstrated in concentration curves that are below and further away from the line of equality (Figure 6).

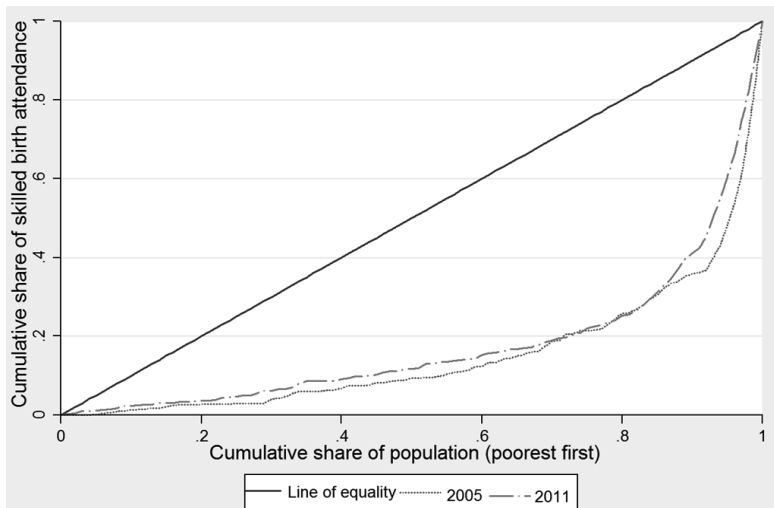


Figure 6: Concentration curves for skilled birth attendance in Ethiopia, 2005 and 2011.

Prevalence of diarrhea and stunting has decreased between 2005 and 2011 survey years (Paper I, Table 1). The concentration indices for all morbidities are negative, indicating a higher burden among children from poor households. Among the morbidity variables, the inequality across wealth strata was highest for the prevalence of stunting. The inequality in the rate of stunting has widened over the period 2005–2011, that is demonstrated by the 2011 curve lying furthest away to the line of equality as compared to the 2005 curve (Figure 7). Both the 2005 and 2011 curves in Figure 7 lie above the line of equality suggesting a higher disease burden among the poorest quintiles.

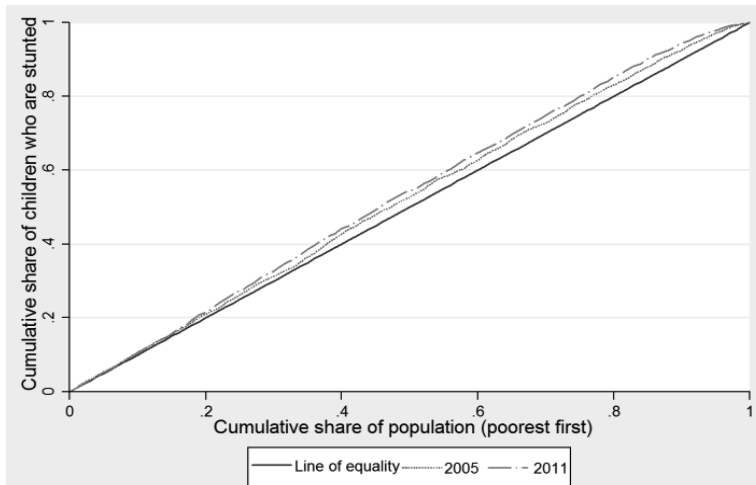


Figure 7: Concentration curves for prevalence of stunting in Ethiopia, 2005 and 2011.

Decomposition of the concentration index shows that the major determinants of the inequality in access to MCH care in Ethiopia were household economic status and educational attainment of parents. Area of residence also contributes to a sizable proportion of the inequality in access to skilled birth attendance to the disadvantage of rural households.

Assessment of the role of PHC expansion on changes in inequality in the utilization of MCH services revealed that services uptake for diarrhea treatment, modern contraceptives and facility delivery in Ethiopia, on average, has improved over the period 2005–2011. Government PHC facilities played the major role for the improvement (Paper I, Table 3).

4.2. Pneumonia and diarrhea treatment expenditures in Ethiopia

Of the 686 patients enrolled in the study (91% response rate), 303, 42, 309 and 32 had been diagnosed with pneumonia, severe pneumonia, diarrhea and severe diarrhea cases, respectively (Paper II, Table 1). The mean total medical expenditures (in 2013 USD) per outpatient visit were \$8 and \$6 for pneumonia services and, diarrhea outpatient services, respectively. Average OOP expenses were higher for inpatient

services at \$64 for severe pneumonia and \$79 for severe diarrhea. Direct medical expenses accounted for the major share of the total medical expenditure. The mean OOP direct medical expenses were \$6 and \$5 for pneumonia and diarrhea outpatient services, respectively; while for inpatient services they were \$51 for severe pneumonia and \$59 for severe diarrhea, respectively. Medication costs contributed to 60% of direct medical expenses. For inpatient care, the second largest expense was the bed charge, constituting 28% of OOP direct medical expenses, followed by diagnostic investigations covering 16% of costs. The average OOP expenses associated with direct non-medical expenses (mainly transport costs) for pneumonia, diarrhea, severe pneumonia and severe diarrhea were \$2, \$2, \$13, and \$20, respectively.

Type of health facility visited was the main predictor of a difference in the mean total medical expenditure for each disease category, where patients incur higher costs in private than public health facilities (Paper II, Table 3). Variations in total medical expenditures for the treatment of pneumonia and diarrhea were also observed among different wealth quintiles, by place of residence (rural vs. urban) and region. The wealthy and urban dwellers were more likely to visit private facilities or government hospitals and therefore spend more for services rendered.

Our findings indicate that OOP expenses for pneumonia and diarrhea can have catastrophic consequences and could lead to impoverishment especially for poor and rural households (Paper II, Table 5). At a threshold of 40% capacity to pay, 0.3% to 0.6% of households incurred catastrophic health expenditure for outpatient care; the incidence was higher for inpatient care, where 7% to 16% of households incurred catastrophic health expenditure. Table 1 and Figure 8 below present the aggregate incidence and intensity of catastrophic health expenditure due to medical payments among visitors of health facilities for pneumonia and diarrhea treatment in Ethiopia. Overall, 1.0% and 1.6% of the households who visited health facilities for the treatment of either pneumonia or diarrhea had catastrophic health expenditures at a threshold of 10% of total expenditure and 40% capacity to pay, respectively.

Table 1: Incidence and intensity of catastrophic health payments aggregated for all conditions[‡], Ethiopia 2013, defined with respect to total expenditure and capacity to pay, various thresholds

<i>Catastrophic payments measures</i>	<i>Threshold budget share</i>				
<i>Out-of-pocket health spending as</i>					
<i>share of total expenditure</i>	<i>5 %</i>	<i>10 %</i>	<i>15 %</i>	<i>25 %</i>	<i>40 %</i>
Head count	3.1%	1 %	0.1%	0	.....
Overshoot	0.12%	0.03%	0.003%	0	.....
Mean positive overshoot	3.9%	3 %	3 %	0	.....
<i>As a share of capacity to pay</i>					
Head count	.....	.....	7.4%	3.5%	1.6%
Overshoot	.....	.....	1.1%	0.6%	0.2%
Mean positive overshoot	.....	.....	14.9%	17.1%	12.5%

[‡]This is an aggregate summary for all disease conditions that include pneumonia, diarrhea, severe pneumonia and severe diarrhea.

As one can observe from the above table, for any threshold level, both the head count and the overshoot are higher (as one might reasonably expect), when catastrophic payments are defined with respect to capacity to pay (nonfood expenditure) than total household expenditure. This is also illustrated in Figure 8. For any given budget share, the OOP/[capacity to pay (nonfood exp.)] curve is to the right of the OOP/[total exp.] curve.

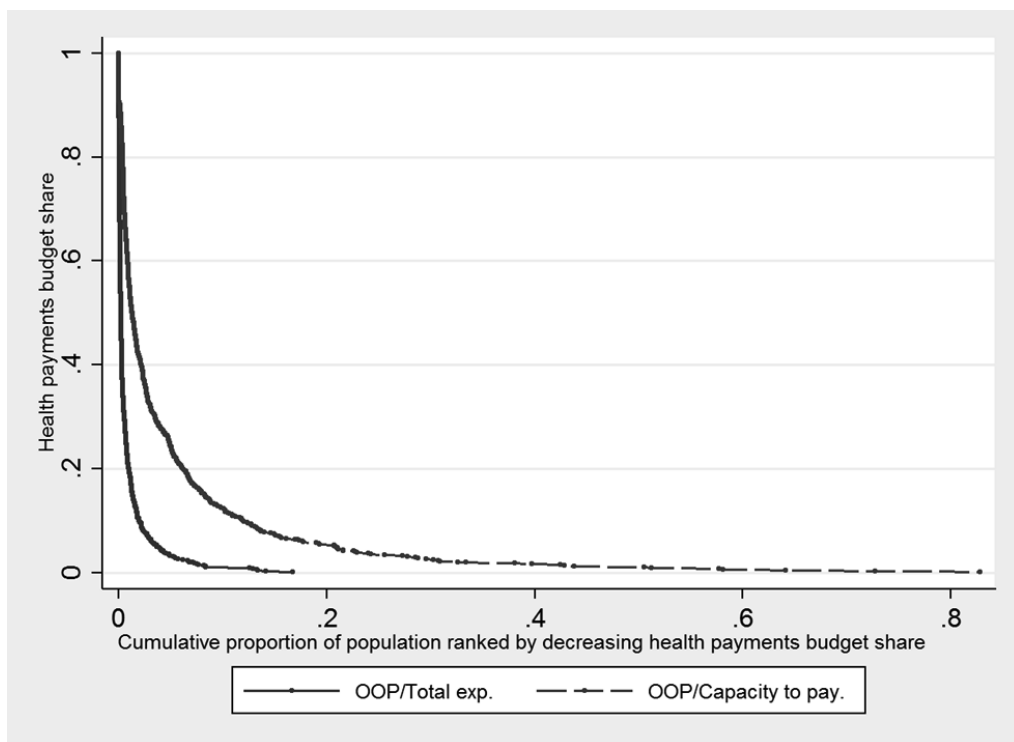


Figure 8: Health care payments budget share (over total expenditure and capacity to pay) against cumulative percentage of households ranked by decreasing budget share, Ethiopia 2013.

Similarly, for outpatient care pneumonia or diarrhea episodes, 0.3% of households were pushed into extreme poverty due to OOP payments. The figures were much higher for inpatient care, where 7% and 6% of the households with severe pneumonia and severe diarrhea cases, respectively, were pushed below the extreme poverty line (Table 2).

Table 2: Impoverishment levels for different measures of poverty based on gross consumption and net of health spending, Ethiopia 2013

		Gross of health payment (1)	Net of health payment (2)	Difference	
				Absolute (3)=(2)- (1)	Relative [(3)/(1)]*10 0
\$1.25 per day poverty line					
Aggregate	Poverty head count	3.8 %	4.7 %	0.9 %	23.1 %
	Poverty gap (ETB)	27.2	38.3	11.1	41.0 %
	Normalized poverty gap	0.85 %	1.20 %	0.35 %	41.0 %
Pneumonia	Poverty head count	4.29 %	4.29 %	0.00 %	0.0 %
	Poverty gap (ETB)	33.5	35.1	1.6	4.7 %
	Normalized poverty gap	1.05 %	1.11 %	0.05 %	4.8 %
Diarrhea	Poverty head count	4.2 %	4.5 %	0.32 %	7.7 %
	Poverty gap (ETB)	27.5	29.6	2.1	7.6 %
	Normalized poverty gap	0.86 %	0.93 %	0.07 %	7.6 %
Severe pne.	Poverty head count	0.0 %	7.1 %	7.1 %	.....
	Poverty gap (ETB)	0.0 %	60.6	60.6	.....
	Normalized poverty gap	0.0 %	1.91 %	1.91 %	.....
Severe Dia.	Poverty head count	0.0 %	6.3 %	6.3 %	.....
	Poverty gap (ETB)	0.0 %	123.0	123.0	.....
	Normalized poverty gap	0.0 %	3.87 %	3.87 %	.....

For Ethiopia in 2013, we estimated that more than 150,000 households incurred CHE (at a threshold of 40% capacity to pay), and almost 80,000 households were pushed into poverty due to OOP payments for childhood pneumonia and diarrhea treatment (Table 3).

Table 3: Annual estimates of households with CHE and impoverishment due to OOP payments for the treatment of childhood pneumonia or diarrhea, Ethiopia 2013.

	Population, 0-4 years in 2013 (millions) (UNPD, 2013)	Annual disease incidence	Health service utilization rate (EDHS 2011)	Percent of households incurring CHE*	Percent of households pushed into poverty [#]	Number of households incurring CHE*	Number of households pushed into extreme poverty [#]
Pneumonia	14.2	0.29	27 %	0.3%	0.0%	3 685	0
Diarrhea	14.2	3.30	32 %	0.6%	0.3%	97 096	48 549
Severe pneumonia	14.2	0.03	27 %	7%	7 %	9 165	9 165
Severe diarrhea	14.2	0.07	32 %	16%	6 %	46 728	18 691

*At 40% capacity to pay threshold. [#]Households pushed below PPP \$1.25 a day.

4.3. Cost-effectiveness analysis of maternal and neonatal interventions

The results of the cost-effectiveness analysis of maternal and neonatal interventions showed that all interventions except calcium supplementation were very cost-effective with incremental cost-effectiveness ratios less than one time GDP per capita (Table 4). Calcium supplementation was not cost-effective for a threshold of three times GDP per capita in Ethiopia. Interventions for newborn care were found to be highly cost-effective (e.g. Kangaroo mother care, neonatal resuscitation, newborn sepsis management, antibiotics for preterm prelabor rupture of membrane) followed by selected antenatal interventions (e.g. tetanus toxoid and syphilis diagnosis and treatment for pregnant women), and by more complex interventions that require care at secondary/tertiary level facilities. Delivery of interventions in packages is more cost-effective than delivering single interventions.

Table 4: Annual costs, effects and cost-effectiveness ratios of maternal and neonatal interventions at 80% coverage in Ethiopia in 2011

No.	Description of the intervention	Total annual cost (millions)	Yearly Healthy Life Years gained (millions), Discounted	CER [~] (USD per Healthy Life Year gained)
1	Neonatal resuscitation (institutional)	1.8	0.143	13
2	Induction of labor (beyond 41 weeks)	2.4	0.010	229
3	Kangaroo mother care	2.3	0.244	10
4	Management of pre-eclampsia and eclampsia	3.1	0.026	120
5	Safe abortion	3.1	0.015	210
6	Antibiotics for pPRoM	4.1	0.090	46
7	Syphilis detection and treatment	4.4	0.056	78
8	Maternal sepsis case management	4.4	0.015	283
9	Active management of the 3 rd stage of labor	4.9	0.029	170
10	Newborn sepsis - injectable antibiotics	5.8	0.150	39
11	Tetanus toxoid	6.1	0.100	61
12	Package I	8.8	0.151	58
13	Antenatal corticosteroids for preterm labor	14.8	0.189	78
14	Calcium supplementation	15.4	0.005	2 809
15	Package II	26.2	0.506	52

Package I includes syphilis detection and treatment and tetanus toxoid for pregnant women. Package II includes interventions included in Package I plus antenatal steroid for preterm labor, antibiotics for pPROM and management of pre-eclampsia and eclampsia. [~]The column presents cost-effectiveness ratio of each intervention that are incremental to the null scenario.

Implementation of all twelve individual interventions (except calcium supplementation) at 80% uptake would avert 36,500 neonatal deaths (44% reduction from baseline) and 3,800 maternal deaths (42% reduction from baseline).

The sensitivity analysis showed that there is a substantial uncertainty that resides within the cost-effectiveness estimates. We also did a sensitivity analysis by varying

the level of treatment adherence. At 100% and 75% of treatment adherence, all interventions included in our analysis except calcium supplementation were very cost-effective. At 50% treatment adherence, apart from calcium supplementation and maternal sepsis case management, all other interventions were very cost-effective.

5. Discussion

5.1. Methodological considerations

Here we discuss general methodological issues pertaining to all three studies included in this thesis starting with paper I that addresses the analysis of inequality/inequity in maternal and child health in Ethiopia. The first step in health equity analysis is the identification of an appropriate source of data. There are different sources of data having their own advantages and respective limitations. Household survey data (for example, demographic and health surveys) are the most important source of data for health equity analysis [54]. They have rich data on health, living standards and other complementary variables (such as education, geographic location, availability of safe water and sanitation facilities, etc.) that allow both health equity analysis and a multivariate analysis to understand why observed inequalities arise. DHS are conducted on a nationally as well as sub nationally representative (for example, regions in Ethiopia) sample on a regular basis making them also suitable for trend analysis.

DHS uses a complex sampling design due to the impracticality of a single stage random sampling design (this is the “gold standard” sampling method, in which every element in the sampling frame has equal chance of being selected). This is usually due to the high cost and logistical constraints in visiting a randomly selected sample and to allow representativeness of some subpopulation groups because the random sampling would contain “too few” members. The survey sample in Ethiopia was selected through a two-staged stratified cluster sampling process, with stratification by region and area (urban vs. rural), enumeration areas were the sampling units for the first stage, followed by sampling of households within each enumeration area. To avoid biases resulting from such designs, each observation was weighted proportional to the inverse of the probability of being sampled. In both health inequity analysis and multivariate analysis we took into account the complex sample design of the survey data.

The living standard measure used in DHS is an asset index constructed from data on household assets using principal component analysis. Collection of asset and housing characteristic data is easier and less susceptible to measurement error making asset index a preferred option in large surveys such as DHS. Consumption data are seen by some as a better living standard measure, but may be more susceptible to measurement error and such data are expensive to collect [75, 76]. Comparisons of measured inequality in nutritional status of children in 19 countries find that for most countries the choice of a welfare measure (consumption vs. asset index) failed to make a significant difference to the degree of socioeconomic inequality in malnutrition [77].

Regardless of the importance of survey data in health inequity assessment, it is not without limitations. Recall bias is one possible problem in surveys as they are based on maternal recall. Differential reporting by rich and poor mother's and between urban and rural residents is also a concern for a possible bias. The other limitation is the living standard measure used in DHS. We have observed that the wealthiest quintile tends to reside in urban areas, particularly in the capital city, so that wealth inequities are closely associated with urban/rural disparities. Apart from limitations associated with survey data, there were additional limitations to our equity analysis. In our study, the contribution of need factors to the horizontal inequity index was negligible. This could lead to a biased measurement of the horizontal inequity index if there were other need factors (which we failed to include) that vary with income. Additionally, in the computation of concentration indices for binary outcomes, we used a linear regression model that may lead to inaccuracies.

Unlike cross-sectional surveys that are good sources of data for health inequity assessment, the ideal data source for the analysis of catastrophic payments and impoverishment are longitudinal observations that assess how health shocks disrupt consumption paths [78]. In the absence of longitudinal data, OOP health payments in excess of a threshold budget share have been used as a proxy for severe disruption to household living standard. This could be captured by collecting data on a

representative sample of the population through household surveys. Data collected at household level provides information about users and nonusers of health services as well as those who use alternative treatment modalities, which is not possible if one chooses facility exit polls as the data collection method. Facility exit polls only address health service users and are likely to be biased towards better-off individuals and urban residents. This was one of the limitations of our study as it disproportionately represents urban and wealthy households. In our sample, only 5% of the households were below the extreme poverty line, well below the national figure.

Regardless of the advantages of population-based household surveys, they require high cost and logistics as compared to exit polls. We calculated a sample size of 325 patients for the assessment of OOP expenses for pneumonia using facility exit polls as the data collection method. In calculating the sample size, we used a mean difference of at least 3.0 ETB across successive wealth quintiles with a standard deviation of 6.1 ETB at 95% level of confidence and a power of 80 [79, 80]. In order to get the same number of patients who had accessed health care facilities and therefore incurred health care costs, we estimated that it would require collecting data from nearly 24,000 households.² This was clearly beyond the capacity of this PhD project; therefore we opted for an exit interview (complemented by follow-up household data collection) that is less costly and logistically not as demanding as household surveys.

Apart from being less costly and easy to conduct, exit polls have several other advantages. Data on OOP expenses and other characteristics of visits are more likely to be accurate. This is related to the timing of the data collection in exit polls. Data on OOP expenses was collected immediately when incurred, thereby minimizing recall bias. The type of illness is more likely to be correct as it follows a disease diagnosis

² We used pneumonia because it has a lower incidence as compared to diarrhea. We assumed a pneumonia episode of 0.29 per child per year, 2 children under five years per household, health care service utilization of 27% for cases of pneumonia and a recall period of one month.

by a clinician. Household surveys on the other hand rely on reports of symptoms by parents. Fast breathing and/or chest indrawing are major criteria for case finding in acute respiratory infection clinical management [81, 82]. A study conducted in Ethiopia on mothers' perceptions and practices in the care of children with acute respiratory infections found that mothers were not familiar with the symptom of fast breathing or chest indrawing [83].

We used the integrated management of childhood illnesses (IMCI) algorithm in the identification of pneumonia and diarrhea for outpatient cases especially in primary health care facilities. IMCI is a global strategy that has been adopted by more than 100 countries. Ethiopia introduced the IMCI strategy more than a decade ago. In 2012/2013 in Ethiopia, 73% of the health centers and 81% of health posts used this approach to manage childhood illnesses [8]. Health workers are trained on how to assess, classify, and manage children younger than 5 years who have common illnesses. The guidelines are intended for use by all types of health workers (doctors, health officers, nurses, or community health workers) who, after being trained in IMCI, provide care in first-level outpatient health facilities [84]. For Inpatient cases in hospitals, adherence to IMCI algorithm was less likely and patients usually undergo additional laboratory and imaging tests that actually helped in refining the diagnosis but would have implication on costs.

To assess the level of impoverishment and catastrophic health expenditure related to OOP expenses for the treatment of diarrhea and pneumonia we collected data on household consumption expenditure that included both market transactions and consumptions from home productions. In this study, we preferred to measure household consumption expenditures rather than household income. In developing countries like Ethiopia, formal employment is less common, many households have multiple and continually changing source of income and home production is a common practice. In such situations, it is generally far easier to measure household consumption expenditures than income [85]. The other compelling reason for choosing consumption expenditure over income was associated with the nature of

income, which is, income is usually received intermittently whereas consumption can be “smoothed” over time. Consumption expenditure over a period (for example, a month) could indicate the level of consumption for a full year while measured income over the same period is unlikely to be an accurate measure of income for a full year. Additionally, in the assessment of catastrophic health payments, the ratio of health payments to income is not responsive to ways of health care financing. This is illustrated by comparing two households with same income and health payment, where one household has savings to finance health care while the other has no saving and obliged to decrease the level of current consumption to pay for health care. Comparing health payment to income will have the same ratio for both households but the ratio of health care payment to household consumption will be larger for the household without saving.

In our study, consumption expenditures data was collected using households as a unit of observation. In order to obtain individual level estimates, it was necessary to adjust household estimates of aggregate consumption to reflect household size and composition. This was done by defining the number of adult equivalents (AE) in the household as

$$AE = (A + \alpha K)^\theta,$$

where A is the number of adults in the household, K is the number of children, α is the “cost of children,” and θ reflects the degree of economies of scale [86]. Based on what was proposed by Deaton and Zaidi [87], we chose a value of 0.3 for α and 0.9 for θ , because of the relatively limited economies of scale and the larger share of food as a proportion of total consumption.

There are some limitations associated with household consumption expenditure data collection. Recall bias is a concern more so in our study because data was collected as exit poll at a time parents are more concerned about the illness of their child. Consumption may vary seasonally especially for food items that may reduce accuracy of estimation of yearly consumption. Some of purchased goods may not be immediately consumed. Furthermore, we have identified several possible limitations

in the analysis of household medical expenditures for pneumonia and diarrhea (Paper II). Our findings on OOP medical expenses could be an under-estimation for two reasons; (1) we did not factor productivity loss into cost estimates (we presented only time loss), and (2) households may incur additional costs after two weeks of follow-up. Additionally, we failed to reach 16% of the households for follow-up interviews. Our study did not include cases of pneumonia or diarrhea for which households did not seek care—and therefore did not incur any cost—or those that directly go to the pharmacy or visit traditional healers; these exclusions could lead to over-estimation of medical expenses and incidence of CHE in our findings. The number of poverty cases could be underestimated due to the inherent failure to count those who are already below the poverty line and are pushed into deeper poverty. Because of the small number of inpatient cases of severe pneumonia and diarrhea, the results of subgroup analyses should be interpreted with caution. Average OOP expenses may be overestimated given that our sample was disproportionately comprised of urban and wealthier households. On the contrary, the higher proportion of urban and wealthier households in our sample could underestimate the level of impoverishment and CHE. The high proportion of severe cases in Addis Ababa could inflate the mean cost of treatment for cases of severe pneumonia and diarrhea. Furthermore, we did not assess the source of funding for treatment episodes (e.g. saving, borrowing, selling assets, etc.).

In addition to data on household consumption expenditure, we collected data on household assets for the construction of asset index. We compared asset index constructed using principal components analysis and consumption and found a correlation of 0.49 that was slightly better than what was reported by others [54].

In the cost-effectiveness study (Paper III), despite availability locally relevant cost data, intervention efficacy data was not available in Ethiopia. The efficacy data we used were derived from studies conducted in more developed countries with higher quality of services and may not translate directly to the Ethiopian setting. For the interventions included in our analysis, we could not envision the availability of local

efficacy data in the near future in Ethiopia. Therefore, we proceeded with our analysis (acknowledging the limitations), because the evidence generated could help the decision making process in Ethiopia until local data on intervention effectiveness will be available. We used data on coverage (uptake) levels from surveys or other studies when available. But for most of the interventions coverage data was lacking. In such cases we used expert opinions as the next best alternative. Data on adherence to care for the interventions included in the analysis was also lacking. Poor adherence is an important factor for suboptimal clinical benefit of interventions particularly for chronic conditions. Except for calcium supplementation that requires a long-term medication, the other interventions included in our analysis only require short-term medical care which is delivered in health care facilities. We conducted a sensitivity analysis by varying the level of adherence for all the interventions in our analysis using 50%, 75% and 100% adherence rates. Data on perinatal mortality was not included in the analysis which may result in under estimation of the cost-effectiveness of some of the interventions (for example, syphilis detection and treatment in pregnant women, calcium supplementation for the prevention of pre-eclampsia/eclampsia).

5.2. Inequalities in utilization of maternal and child health services

Coverage of MCH services has shown improvements in Ethiopia but the inequality by wealth quintile and area of residence has remained persistently high in all surveys. Socioeconomic status, measured by a wealth index and parental educational attainment, were the main predictors of differences in utilization of MCH services and health outcomes in children under five years of age. Area of residence has been a significant contributor for the disparity in access to SBA. Similar findings were observed in rural areas of Nepal, where the proportion of institutional deliveries in urban areas were five times higher than rural parts [88].

Among the health service coverage indicators (2011 DHS), use of modern contraceptive methods was the most inequitably distributed interventions, with a horizontal inequity index of 0.28. The average concentration index for 54 countdown

countries for family planning needs satisfied was 0.14 (IQR: 0.05-0.20), making Ethiopia one of the countries with the most unequal distribution of the service [89]. Another study that was based on demographic and health surveys in Ethiopia found a concentration index of 0.65 for skilled birth attendance, an inequality that is worse than use of modern contraceptives [90]. For skilled birth attendance, all other quintiles except the wealthiest had very low coverage rates. This finding conforms to what has been described a “top inequity”, where access in the wealthiest quintile is considerably greater than the rest of the population [91]. Wealth level and educational attainment of women were the major contributors to the inequity in modern contraceptive usage and skilled birth attendance. Several studies have demonstrated wealth and parental educational attainment as major determinants of access to MCH services in sub-Saharan African countries [92, 93].

Coverage of measles immunization was the most equitably distributed indicator with a horizontal inequity index of 0.08 in the 2011 DHS for Ethiopia and it has shown a significant pro-poor improvement in comparison to the 2005 DHS. Such pro-poor improvements were not observed for other vaccines [13, 90] suggesting that the pro-poor improvement in measles immunization might be related to the “follow-up” measles vaccination campaigns conducted in Ethiopia [94].

PHC facilities have played an increasingly important role as points of care for diarrhea treatment and as a source of modern contraceptive for the less privileged socioeconomic group. Several studies have documented the effect of a scale up and equitable distribution of primary health care infrastructure and intervention coverage on inequality in service utilization and child health outcomes among different socioeconomic groups [95-97]. The role of PHC facilities as points of delivery care services in Ethiopia is relatively low. Public hospitals and private facilities play a major role as delivery care services outlet, more so for the wealthiest quintile and urban residents. A study in a rural district in Uganda showed that the mere availability of primary health care facilities did not improve health services utilization by women and failed to result in a reduction in the rate of maternal deaths [98]. The

main factors were related to lack of resources and skilled staff to improve delivery of quality maternity services, traditional beliefs and the low status of women in the community. Quality of services in health facilities, distance to facility and cultural factors were some of the identified barriers to access maternal and child health services in Ethiopia [13, 99, 100].

Despite formidable health system challenges, the expansion of PHC facilities in Ethiopia seems to have contributed positively to the coverage changes and the pro-poor and pro-rural improvements even though other factors (such as women's education, safe water supply, food security) might have contributed as well. The 2008 World Health Report has reaffirmed the role of PHC as a pathway to achieve UHC and as a core strategy for health systems strengthening [101].

5.3. Pneumonia and diarrhea treatment expenditures in Ethiopia

Our study documented OOP expenses and time loss for the two most common causes of morbidity and mortality in children 0-59 months in Ethiopia. The findings demonstrate that OOP expenditures associated with diarrheal illness or pneumonia, especially inpatient hospital visits for severe cases, can be a substantial economic burden for households. Most of the OOP expenditures (ranging from 74% to 80%) consist of direct medical expenses. Medications were the major contributor to direct medical expenses for both outpatient and inpatient visits, followed by bed charges for inpatient care. Several previous studies conducted elsewhere reported comparable estimates of total household medical expenditures, as well as identifying direct medical expenses and medications as the major drivers of total medical expenditures [102-107]. Among the direct nonmedical expenses, transportation costs presented families with a significant financial hurdle even before accessing needed formal care.

Households OOP expenses varied depending on the facility visited, with households having significantly higher OOP expenses in private health facilities followed by government hospitals. The average OOP expenses for treating pneumonia and diarrhea in private facilities were \$28 per case and \$21 per case, respectively. The

respective amounts in government hospitals were \$12 and \$6. Households incurred the least costs at public PHC facilities. The mean total medical expenditures at health centers for outpatient care of pneumonia or diarrhea were \$4.1 and \$3.9, respectively. Marked variations in OOP medical expenses by level of care (primary to tertiary) for the treatment of pneumonia or diarrhea were also documented by others [102, 107, 108]. In a study assessing economic burden of inpatient pediatric care in Kenya, the household OOP expense for pneumonia was less than \$20 in district hospitals while it was \$65 in tertiary level care facilities [102]. Another study in India found that the household OOP expenses for inpatient pneumonia cases were \$41 and \$135 for secondary and tertiary levels of care, respectively [107].

At health posts, both preventive and curative services are supposed to be delivered free of charge in Ethiopia. According to our findings this was not always true. Even though consultation fees were not paid, parents were obliged to buy medication from private outlets because of drug stock out at health posts. In most of the health centers, parents paid fees for consultation and medications. There were variations in the amount of user fees for similar services in public health facilities located in different regions that might be related to regional autonomy in deciding the amount of user fees.

There were marked variations in total medical expenditure by place of residence and wealth quintile. The wealthy and urban households tend to spend more on treatment than poor and rural households. Urban households and wealthier quintiles were more likely to visit private facilities or public hospitals where the perceived quality of care is superior. Barnet and Tefera (2010) reported a preference by poor households in Ethiopia to go to a higher-level health facility because the quality and quantity of services one could receive at PHC facilities was perceived as inferior [109]. Despite such perceptions, poor households were less likely to visit facilities where they are more likely to incur higher expenditure which could be related to households' inability to absorb medical payments.

The health care financing reform in Ethiopia (2005) allowed public health facilities to collect, retain, and use the revenues and user fees that they generate from different sources, as an addition to the government budget, for improving the quality of health services [110]. The retained revenues generated from user fees covered 56% of the total health budget for health centers in the year 2011/2012 [111]. A system of fee waivers and exemptions was part of the reform. Despite fee waivers for preventive child health services, the OOP expenditures for curative care for children is a burden in Ethiopia, accounting for close to 50% of total child health care expenditures in 2010-2011 [112]. User fees at public health facilities are associated with decreased service utilization, even more so for marginalized segments of the population such as women, children and the poor [104, 113, 114]. Evidence from similar settings in Africa also suggests that abolition of user fees results in increased service utilization in all population groups [115]. User fees could hamper the Ethiopian government's efforts to make essential priority services universally accessible [116]. One of the fundamental impediments to universal health coverage is over reliance on direct payments at the time people need care [117, 118].

5.4. Cost-effectiveness analysis of maternal and neonatal interventions

Maternal and neonatal conditions are among the major causes of morbidity and mortality in Ethiopia [119-121]. In paper III, we analyzed the cost effectiveness of interventions that address the major causes of maternal and neonatal morbidity and mortality. Except calcium supplementation that was not implemented in public health facilities, all interventions included in our analysis are not entirely new to the Ethiopian health system. However, most of the interventions had a very low uptake rate. Therefore, assessing the cost-effectiveness of interventions that are currently implemented as well as those that could potentially be introduced can assist policy makers and planners in Ethiopia to prioritize interventions scale-up.

Our analysis showed that all single interventions and packages, besides calcium supplementation, were very cost-effective in Ethiopia. Adam et al. in their cost-

effectiveness analysis of strategies for maternal and neonatal health in developing countries have reported a similar pattern to what we found (calcium supplementation and safe abortion were not included in their analysis) [122]. A study conducted on the cost-effectiveness of calcium supplementation in Colombia concluded that varying the cost of calcium tablets or the incidence of preeclampsia rendered the intervention no longer cost-effective for a threshold of three times Colombia's GDP per capita [123].

Most of the interventions included in our analysis could be scaled up using primary health care facilities as delivery platforms. In the last decade in Ethiopia, there was a rapid expansion of primary health care facilities comprised of health centers and health posts, which represents an opportunity to scale up maternal and neonatal interventions in both health centers and at the community level [8, 10]. Since late 2009, community case management of common childhood illnesses (mainly treatment of pneumonia, diarrhea and malaria in children under five years old) has been implemented in Ethiopia at community level using health extension workers [124]. One area that needs further consideration is the introduction of kangaroo mother care along with breastfeeding support for preterm/low birth weight newborns at community level, though the evidence available so far is insufficient [125]. Management of neonatal infection with antibiotics and community care of newborns were found to be effective in reducing neonatal mortality and scalable at community level [126, 127]. Delivery of services at the community level using health extension workers has the additional benefit of bringing care to all women and infants, particularly to those socioeconomically disadvantaged and marginalized rural residents.

Safe abortion care is one of the cost-effective services that can be delivered effectively at primary health care facilities. The cost of treatment from the provider perspective to provide safe abortion using the medical method (vaginal misoprostol) for a single case varied between 10 to 24 \$US in Ghana and Nigeria, which is comparable to our estimate of an average cost per patient close to 11 USD [128]. Safe

abortion services at the health center level, such as manual vacuum aspiration or medical abortion using misoprostol resulted in substantial cost savings as compared to dilatation & curettage that is often hospital based. Most public health centers in Ethiopia are not currently providing safe abortion services [15]. The broadening of legal indications for abortion (the 2005 revised family law of Ethiopia) and the issuance of safe abortion technical guidelines in 2006 created a favorable environment to scale-up of safe abortion services in Ethiopia.

Despite the fact that most interventions delivered at community level and in primary health care facilities are very cost-effective, prevention of most maternal and neonatal deaths requires access to quality clinical care services. Improving quality of care is often considered very costly. However, a research project by the Prevention of Maternal Mortality network in West Africa found that renovation or upgrading of essential obstetric care services in district hospitals and health centers was not as expensive as often assumed. Most developing countries have extensive health systems that are often under-utilized. With inputs such as opening operating rooms with a supply of electricity and blood banks, for less than \$15,000, improvement in the provision of quality delivery care services with significant impact on maternal mortality have been seen [129]. The ongoing training of health officers to deliver comprehensive emergency obstetric care and other emergency surgical services, coupled with the primary health care facility expansion could serve as important inputs in the scale up of obstetric care in Ethiopia. Additionally, delivery of quality obstetric and neonatal services requires a reliable supply of medicines, functioning equipment and respectful provider attitude [130]. Cultural factors also influence utilization of facility delivery care services. According to 2014 Ethiopian Mini DHS, 34% of rural women reported that facility deliveries were not customary highlighting the need for enhanced community mobilization [131].

Packaging interventions is more cost-effective than scaling up single interventions due to synergies in costs. Therefore implementation of interventions with common

delivery modes as packages is effective emphasizing the importance of service integration [132].

6. Conclusions

The government of Ethiopia has a vision to become a middle-income country by 2035. In line with the government's vision, the Ministry of health of Ethiopia is developing a 20-year health sector program to achieve health outcomes that are commensurate with lower middle-income countries by 2025 and upper middle income-countries by 2035 [116]. The key strategy is ensuring universal access to basic health interventions for all Ethiopians mainly through strengthening primary health care [15]. The base case scenario targets in Ethiopia for 2025 includes: a maternal mortality ratio of 260 per 100,000 live births, neonatal mortality rate of 28 per 1000 live births, 77% uptake for antenatal care (four visits) and skilled birth attendance, and per capita total expenditure on health of US\$72. The health service uptake targets of key high impact maternal and neonatal interventions over the next 10 years in Ethiopia supports scale-up of interventions included in our analysis to 80% uptake level. Scale-up of all individual interventions (excluding calcium supplementation) included in our analysis to 80% uptake rate can significantly contribute to the 2025 targets set for maternal mortality ratio and neonatal mortality rate.

Among the critical resources of the health system is finance. The total health expenditure in 2010/2011 in Ethiopia was 1.6 billion USD [112]. Excluding calcium supplementation, the other twelve individual interventions could be scaled up to 80% coverage at a yearly cost of 57 million³ USD. The additional budget required for scale-up of these maternal and neonatal interventions is less than 4% of the total health expenditure in 2010/2011 amounting to an increase of US\$1 in per capita health expenditure in Ethiopia. The new global investment frame work for Women's and Children's Health [133] has shown the substantial economic and social benefits of investing in Reproductive, Maternal, Neonatal and Child Health interventions. Nearly half of the reduction in child and maternal deaths was estimated to result from

³ This is an economic cost based on our analysis; the financial cost is expected to be less.

greater access to contraceptives for effective family planning that can be scaled-up at a relatively small cost using PHC as a delivery platform. The expected demographic dividend from the reduction in unintended pregnancy was estimated to exceed 8% of the Gross Domestic Product by 2035 in countries with high fertility rate like Ethiopia. Further reduction in maternal and child mortality requires ensuring a reliable access to an integrated antenatal, intrapartum and postpartum care by skilled attendants [133, 134]. Given the substantial health dividend from investing on universal coverage of the intervention included in our analysis, the government should commit to allocate enough resources for their scale-up.

Our results show that despite government efforts to increase access to preventive services for pneumonia and diarrhea, poor and rural households bear a considerable risk of CHE and impoverishment due to OOP payments when seeking curative care for the treatment of pneumonia and diarrheal illnesses in Ethiopia. For these households, the increased risk of CHE could exacerbate the inequity and impoverishment that are already prevalent in Ethiopia [135]. Ensuring financial risk protection is one of the health sector's objectives, as prescribed in the national health policy of Ethiopia [17]. Achievement of this objective requires revisiting the existing health financing strategy for high priority services that place a substantial burden of payment on households at the point of service delivery.

While great progress has been made in Ethiopia, this analysis demonstrates that there is continued room for improvement to address persistently high inequality across the socio-economic spectrum. Future plans should aim to sustain current successes in health system strengthening and to bring these benefits to all women and children, particularly to those socioeconomically marginalized and rural residents. Equity and quality health services delivery are among the pillars of the health transformation agendas for the next five years in Ethiopia [15]. In addition to continued improvements to Ethiopia's health sector, investments in women's education and implementing pro-poor policies will be critical to maximize equitable health gains

and population wide benefits. Monitoring the progress of intervention implementation should have an equity perspective [32].

7. Future perspectives

Extended cost-effectiveness analysis allows an assessment of multiple benefit streams when considering public finance of health interventions [50-52]. Ethiopia has recently introduced pneumococcal conjugate vaccine and rotavirus vaccine as part of the basic vaccine program. Reduction in new cases of pneumonia and diarrhea may offer protection against impoverishment and OOP expenditures for such diseases. The potential impact of universal public financing (UPF) of vaccines and curative childhood interventions for diarrheal illnesses and pneumonia on health gains and financial risk protection in Ethiopia was examined previously by others [136, 137]. An important limitation of the studies was absence of primary cost data for the estimation of financial risk protection afforded to households. Additionally they did not specifically assess the impact of UPF on poverty reduction. Better estimates of the current household OOP expenses allow for more precision in estimating the expected poverty impact of these new vaccines.

Generalized cost-effectiveness analysis is important in that it allows the identification of current allocative inefficiencies as well as opportunities presented by new interventions, thereby facilitating scale-up of an optimal mix of interventions [59]. Our analysis does not include all possible maternal and neonatal interventions that could be considered in Ethiopia. Additional analysis will therefore be vital in the identification of the optimal mix of interventions to be included in the essential benefits package in Ethiopia. In general, data on disease epidemiology, costs and effectiveness of health interventions is lacking in Ethiopia. Therefore, generating quality data on disease epidemiology, interventions costs and effectiveness, demand and supply side constraints could facilitate the health care priority setting process, especially in regards to the social and community health insurance initiatives in Ethiopia.

References

1. UN Population Division, Population estimates and Projections Section. <http://esa.un.org/unpd/wpp/Excel-Data/population.htm> accessed online.
2. Federal Democratic Republic of Ethiopia Population Census Commission. 2008. Summary and Statistical report of the 2007 Population and Housing Census. Central Statistics Agency; Addis Ababa, Ethiopia.
3. Wikipedia. List of ethnic groups in Ethiopia. https://en.wikipedia.org/wiki/List_of_ethnic_groups_in_Ethiopia accessed online.
4. The World Bank. Ethiopia economic overview. <http://www.worldbank.org/en/country/ethiopia/overview> accessed online.
5. The World Bank. Sub-Saharan Africa (developing only). <http://data.worldbank.org/region/SSA> accessed online.
6. The World Bank. World DataBank. <http://databank.worldbank.org/data/views/reports/tableview.aspx> accessed online.
7. Federal Democratic Republic of Ethiopia Ministry of health. October 2010. Health Sector Development Program IV (2010/2011-2014/2015). Addis Ababa, Ethiopia: Federal Ministry of Health.
8. Federal Ministry of Health (Ethiopia). October 2014. Health and Health related indicators 2005 E.C (2012/2013).
9. WHO (World Health Organization). 1978. "Declaration of Alma-Ata." International Conference on Primary Health Care, Alma-Ata, September 6–12. http://www.who.int/publications/almaata_declaration_en.pdf. Accessed 30 Nov 2015.
10. Federal Ministry of Health of Ethiopia. 2007. Health Extension Implementation Guide. Addis Ababa, Ethiopia: Health Extension Education Center.
11. Central Statistical Agency [Ethiopia] and ICF International. 2001. Ethiopia Demographic Health Survey 2000. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ICF International.
12. Central Statistical Agency [Ethiopia] and ICF International. 2006. Ethiopia Demographic Health Survey 2005. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ICF International.
13. Central Statistical Agency [Ethiopia] and ICF International. 2012. Ethiopia Demographic Health Survey 2011. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ICF International.
14. United Nations Development Programme (UNDP). 2014. Human Development Report 2014 Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience. New York, USA: UNDP.

15. Federal Democratic Republic of Ethiopia Ministry of Health. August 2015. Health Sector Transformation Plan (2015/16-2019/20). Addis Ababa, Ethiopia: Federal Ministry of Health.
16. World Health Organization. 2010. Health systems financing, the path to universal coverage; The World Health Report 2010. Geneva, Switzerland; World Health Organization.
17. The Federal Democratic Republic of Ethiopia. 2015. National health policy. Addis Ababa, Ethiopia.
18. Marmot M. Social determinants of health inequalities. *Lancet*. 2005; 365: 1099–104.
19. Anand S. The concern for equity in health. *J Epidemiol Community Health*. 2002;56:485–487.
20. Daniels N, Kennedy B, Kawachi I. Justice is good for our health: How greater economic equality would promote public health. <http://bostonreview.net/forum/norman-daniels-bruce-kennedy-ichiro-kawachi-justice-good-our-health> accessed on 16/03/2016.
21. Goran Dahlgren and Margaret Whitehead. Concepts and principles for tackling social inequities in health: Levelling up part 1. (University of Liverpool: WHO Collaborating Center for Policy Research on Social Determinants of Health, 2007).
22. Evans T, Peters F (2001). Ethical dimensions of health equity. In: Evans T et al., eds. *Challenging inequities in health: from ethics to action*. New York, Oxford University Press.
23. Sen AK. *Commodities and capabilities*. Amsterdam: North-Holland, 1985.
24. Rawls J. *A theory of justice*. Cambridge, MA: Harvard University Press, 1971.
25. Daniels N. *Just health: Meeting health needs fairly*. New York: Cambridge University Press, 2008.
26. WHO. Universal health coverage: supporting country needs. World Health Organization; 2013. Available from: http://www.who.int/contracting/UHC_Country_Support.pdf accessed on 13/03/16.
27. Norheim OF, Baltussen R, Johri M, Chisholm D, Nord E, et al. Guidance on priority setting in health care (GPS-Health): the inclusion of equity criteria not captured by cost-effectiveness analysis. *Cost Effectiveness and Resource Allocation*. 2014; 12:18: doi: 10.1186/1478-7547-12-18.
28. Sabik LM, Lie RK. Priority setting in health care: lessons from the experiences of eight countries. *International Journal for Equity in Health*. 2008;7:4.
29. Glassman A, Chalkidou K. *Priority-setting in health: building institutions for smarter public spending*. Washington, D.C.: Center for Global Development;2012.

30. Commission on Macroeconomics and Health. *Macroeconomics and health: investing in health for economic development*. Geneva: World Health Organization; 2001.
31. Fleurbaey M, Schokkaert E. Equity in health and health care. In: Pauly M, McGuire T, Pita-Barros P, editors. *Handbook of Health Economics: North-Holland*; 2011.
32. World Health Organization. 2014. *Making fair choices on the path to Universal Health Coverage: Final report of the WHO Consultative Group on Equity and Universal Health Coverage*. Geneva, Switzerland: World Health Organization.
33. Drummond M, McGuire A: *Methods for the economic evaluation of health care programmes*. 2nd edition. Oxford. Oxford University Press; 1997.
34. Williams A. Cost-effectiveness analysis: is it ethical? *Journal of Medical Ethics*. 1992;18:7-11.
35. Nord E. *Cost-value Analysis in Health Care: Making Sense out of QALYs*. New York: Cambridge University Press, 1999.
36. The World Bank *World Development Report 1993: investing in Health*. New York Oxford University Press; 1993.
37. Adam T, Lim SS, Mehta S, Bhutta ZA, Fogstad H, Mathai M, et al. Cost effectiveness analysis of strategies for maternal and neonatal health in developing countries. *BMJ* 2005;331 doi: <http://dx.doi.org/10.1136/bmj.331.7525.1107>.
38. Hutubessy R, Chisholm D, Edejer TT. Generalized cost-effectiveness analysis for national-level priority-setting in the health sector. *Cost Effectiveness and Resource Allocation*. 2003, 1:8.
39. Adam T, Evans DB, Koopmanschap MA: Cost-effectiveness analysis: can we reduce variability in costing methods? *Int J Technol Assess Health Care* 2003, 19:407-420.
40. Hutubessy RCW, Baltussen RMPM, Tan Torres-Edejer T, Evans DB: Generalised cost-effectiveness analysis: an aid to decision making in health. *Applied Health Economics and Health Policy* 2002, 1:89-95.
41. Dolan, P. and Shaw, R. and Tsuchiya, A. and Williams, A. (2004) QALY maximisation and people's preferences: a methodological review of the literature. *Health Economics*. 14(2):pp. 197-208.
42. Schwappach, D.L.B.: Resource allocation, social values and the QALY: a review of the debate and empirical evidence. *Health Expect*. 2002; 5(3), 210–222.
43. van de Wetering EJ, Stolk EA, van Exel NJA, Brouwer WBF. Balancing equity and efficiency in the Dutch basic benefits package using the principle of proportional shortfall. *European Journal of Health Economics*. 2013;14:107-15.
44. Ottersen T. Lifetime QALY prioritarianism in priority setting. *J Med Ethics*. 2012;0:1-6. doi:10.1136/medethics-2012-100740.

-
45. Olsen JA. Priority Preferences: “End of Life” Does Not Matter, But Total Life Does. *Value in Health*. 2013; 16: 1063-1066.
 46. Jonsen A. Bentham in a box: technology assessment and health care allocation. *Law and Medical Health Care*. 1986;14:172-4.
 47. Persad G, Wertheimer A, Emanuel EJ. Principles for allocation of scarce medical interventions. *Lancet*. 2009; 373: 423–31.
 48. Williams, A.: Intergenerational equity: an exploration of the ‘fair innings’ argument. *Health Econ*. 1997; 6(2), 117–132.
 49. Dolan, P., Olsen, J.A.: Equity in health: the importance of different health streams. *J. Health Econ*. 2001. 20(5), 823–834.
 50. Verguet S, Laxminarayan R, Jamison DT. Universal public finance of tuberculosis treatment in India: an extended cost-effectiveness analysis. Published online in *Health Economics*. 2014.
 51. Verguet S, Murphy S, Anderson B, Johansson KA, Glass R, Rheingans R. Public finance of rotavirus vaccination in India and Ethiopia: an extended cost-effectiveness analysis. *Vaccine*. 2013;31:4902-10.
 52. Verguet S, Olson ZD, Babigumira JB, et al. Health gains and financial risk protection afforded by public financing of selected interventions in Ethiopia: an extended cost-effectiveness analysis. *Lancet Glob Health*. 2015;3: e288–96.
 53. Memirie ST, Norheim OF, Levin C, et al. Household expenditures on pneumonia and diarrhea treatment in Ethiopia: a facility-based study. *Tropical Medicine and International Health*. Under review.
 54. O’Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. *Analysing health equity using household survey data: a guide to techniques and their implementation*. Washington, D.C.: The World Bank; 2008.
 55. Pritchard C, Sculpher M. 2005. *Productivity costs: principles and practice in economic evaluation*. London, United Kingdom.
 56. Xu K. 2005. *Distribution of health payments and catastrophic expenditures methodology*. Discussion Paper, Department ‘Health System Financing’ (HSF). Geneva; World Health Organization.
 57. World Health Organization. *Cost effectiveness and strategic planning (WHO-CHOICE)*. <http://www.who.int/choice/cost-effectiveness/en/> accessed October 30, 2014.
 58. World Health Organization. 2003. *Making Choices in Health: WHO Guide to Cost-effectiveness Analysis*. Geneva, Switzerland: World Health Organization.
 59. Murray CJL, Evans DB, Acharya A, Baltussen R. Development of WHO Guidelines on generalized cost-effectiveness analysis. *Health Econ*. 2000; 9:235-251.

-
60. Pollard SL, Mathai M, Walker N. Estimating the impact of interventions on cause specific maternal mortality: a Delphi approach. *BMC Public health*. 2013; 13 Suppl3: S12.
 61. Blencowe H, Lawn J, Vandelaer J, Roper M, Cousens S. Tetanus toxoid immunization to reduce mortality from neonatal tetanus. *International Journal of Epidemiology*. 2010; 39:i102–i109.
 62. Blencowe H, Cousens S, Kamb M, Berman S, Lawn JE. Lives Saved Tool supplement detection and treatment of syphilis in pregnancy to reduce syphilis related still births and neonatal mortality. *BMC Public Health*. 2011;11 Suppl 3: S9.
 63. Imdad A, Jabeen A, Bhutta ZA. Role of calcium supplementation during pregnancy in reducing risk of developing gestational hypertensive disorders: a meta-analysis of studies from developing countries. *BMC Public Health*. 2011;11 Suppl 3: S18.
 64. Jabeen M, Yakoob MY, Imdad A, Bhutta ZA. Impact of interventions to prevent and manage preeclampsia and eclampsia on still births. *BMC Public Health*. 2011;11 Suppl 3: S6.
 65. Ronsmans C, Campbell O. Quantifying the fall in mortality associated with interventions related to hypertensive diseases of pregnancy. *BMC Public Health*. 2011;11 Suppl 3:S8.
 66. Cousens S, Blencowe H, Gravett M, Lawn JE. Antibiotics for pre-term pre-labor rupture of membranes: prevention of neonatal deaths due to complications of pre-term birth and infection. *International Journal of Epidemiology*. 2010;39 Suppl 1:i134-i143.
 67. Mwansa-Kambafwile J, Cousens S, Hansen T, Lawn JE. Antenatal steroids in preterm labor for the prevention of neonatal deaths due to complications of preterm birth. *International Journal of Epidemiology*. 2010;39 Suppl 1: i122-i133.
 68. Hussain AA, Yakoob MY, Imdad A, Bhutta ZA. Elective induction for pregnancies at or beyond 41 weeks of gestation and its impact on still births: a systematic review with meta-analysis. *BMC public Health*. 2011;11 Suppl 3: S5.
 69. Lee AC, Cousens S, Wall SN, Niermeyer S, Darmstadt GL, Carlo WA, et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: a systematic review, meta-analysis and Delphi estimation of mortality effect. *BMC Public Health*. 2011;11 Suppl 3: S12.
 70. Zaidi AKM, Ganatra HA, Syed S, Cousens S, Lee A, Black R, et al. Effect of case management on neonatal mortality due to sepsis and pneumonia. *BMC Public Health*. 2011;11 Suppl 3:S13.
 71. Lawn JE, Mwansa-Kambafwile J, Barros FC, Horta BL, Cousens S. Kangaroo mother care to prevent neonatal deaths due to preterm birth complications. *International Journal of Epidemiology*. 2010;39: i144-i154.

-
72. Management Science for Health. International drug price indicator guide. 2013 Edition. <http://www.msh.org/blog/2014/07/30/2013-international-drug-price-indicator-guide-now-available> accessed on 01 April 2014.
 73. Joint Medical Store. 2014 Catalogue and Price indicator. Kampala, Uganda: JMS.
 74. Baltussen RM, Hutubessy RC, Evans DB, Murray CJ. Uncertainty in Cost-Effectiveness analyses: Probabilistic uncertainty analysis and Stochastic league tables. *International Journal of Technology Assessment in Health Care*. 2002;18:1:112–19.
 75. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data – or TEARS: An application to educational enrollments in states of India. *Demography*. 2001; 38:1, 115-132.
 76. Sahn DE, Stifel DC. Exploring alternative measures of welfare in the absence of expenditure data. *Review of Income and Wealth*. 2003; 49:4, 463-489.
 77. Wagstaff, A., van Doorslaer, E. and Watanabe, N. (2003), “On Decomposing Health Sector Inequalities, with an Application to Malnutrition Inequalities in Vietnam”. *Journal of Econometrics*. 2003; 112:1, 207-223.
 78. Gertler P, Gruber J. Insuring consumption against illness. *American Economic Review*. 2002; 92:1, 51-70.
 79. World Health Organization. 2003. World health survey: Report of Ethiopia. Geneva; World Health Organization.
 80. Deressa W, Hailemariam D, Ali A. Economic costs of epidemic malaria to households in rural Ethiopia. *Tropical Medicine & International Health*. 2007; 12(10): 1148-1156.
 81. World Health Organization. 1991. Supervisory skills: management of the young child with an acute respiratory infection. Geneva; World Health Organization.
 82. Campbell H, Byass P, Lamont AC, et al. Assessments of clinical criteria for identification of severe acute lower respiratory tract infections in children. *Lancet*. 1988; ii:742-743.
 83. Muhe L, Kidane Y, Shamebo D, Krantz I, Freij L. The Butajira Rural Health Project in Ethiopia: Mothers’ perceptions and practices in the care of children with acute respiratory infections. *International Journal of Health Sciences*. 1994; 5:3, 99-103.
 84. Gove S. Integrated management of childhood illness by outpatient health workers: technical basis and overview. *Bull World Health Organ*. 1997; 75 (suppl 1): 7–24.
 85. Deaton A, Grosh M. Consumption. In: Grosh, M., Glewwe, P. (Eds.), *Designing Household Questionnaires for Developing Countries: Lessons from Fifteen Years of the Living Standards Measurement Study*. World Bank: Washington DC; 2000, 91–133.
 86. Cirto C, Michael R. *Measuring poverty: A new approach*. Washington DC; National Academy Press, 1995.

87. Deaton A, Zaidi S. Guidelines for constructing consumption aggregates for welfare analysis. Washington: World Bank; 2002.
88. Acharya PP, Rimal D. Pregnancy and childbirth in Nepal: women's role and decision making power. Selin. H. (Ed), *Childbirth across cultures, science across the cultures: The history of non-western science*, 5. Springer Science and Business Media. 2009
89. Barros AJD, Ronsmans C, Axelson H, Loaiza E, Bertoldi A, França G, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet*. 2012;379:1225–33.
90. Skaftun EK, Ali M, Norheim OF. Understanding Inequalities in Child Health in Ethiopia: Health Achievements Are Improving in the Period 2000–2011. *PLoS ONE*. 2014; doi:10.1371/journal.pone.0106460
91. Victora CG et al. Co-coverage of preventive interventions and implications for child-survival strategies: evidence from national surveys. *Lancet*. 2005; 366(9495):1460–1466.
92. Van Malderen C, Ogali I, Khasakhala A, Muchiri SN, Sparks C, Van Oyen H, et al. 2013. Decomposing Kenyan socioeconomic inequalities in skilled birth Attendance and measles immunization. *International Journal for Equity in Health*. 2013; doi: 10.1186/1475-9276-12-3.
93. Adewemimo AW, Msuya SE, Olaniyan CT, Adegoke AA. Utilization of skilled birth attendance in Northern Nigeria: A cross-sectional survey. *Midwifery*. 2014; 30: e7-e13.
94. Federal Ministry of Health. 2015. Ethiopia National Expanded Program on Immunization: Comprehensive Multi-Year Plan (2016 – 2020). Addis Ababa, Ethiopia; Federal Ministry of Health.
95. Vapattanawong P, Hogan M.C, Hanvoravongchai P, Gakidou E, Vos T, Lopez AD, et al. Reductions in child mortality levels and inequality in Thailand: analysis of two censuses. *The Lancet*. 2007;369(9564):850-855.
96. Macinko J, Guanais FC, de Fatima M, de Souza M. Evaluation of the impact of the family health program on infant mortality in Brazil, 1990–2002. *Journal of Epidemiology and Community Health*. 2006;60(1):13-9.
97. Masanja H, Schellenberg JA, de Savigny D, Mshinda H, Victora CG. Impact of integrated management of childhood illness on inequalities in child health in rural Tanzania. *Health Policy Plan*. 2005; 20 Suppl 1:i77–i84.
98. Kyomuhendo GB. Low Use of Rural Maternity Services in Uganda: Impact of Women's Status, Traditional Beliefs and Limited Resources. *Reproductive Health Matters*. 2003;11(21):16–26.

-
99. Federal Ministry of Health [Ethiopia], UNICEF, UNFPA, WHO and AMDD. National Baseline Assessment for Emergency Obstetric & Newborn Care Ethiopia 2008.
 100. Kruk ME, Paczkowski MM, Tegegn A, Tessema F, Hadley C, Asefa M, et al. Women's preferences for obstetric care in rural Ethiopia: a population-based discrete choice experiment in a region with low rates of facility delivery. *J Epidemiol Community Health*. 2010;64:984-988.
 101. World Health Organization. 2008. World Health Report 2008: Primary health care – Now more than ever. Geneva, Switzerland: World Health Organization.
 102. Ayieko P, Akumu AO, Griffiths UK, English M: The economic burden of inpatient paediatric care in Kenya: household and provider costs for treatment of pneumonia, malaria and meningitis. *Cost Eff Resour Alloc*. 2009; 7:3.
 103. Chola L and Robberstad B. Estimating average inpatient and outpatient costs and childhood pneumonia and diarrhoea treatment costs in an urban health centre in Zambia. *Cost Effectiveness and Resource Allocation*. 2009; 7:16 doi:10.1186/1478-7547-7-16.
 104. Rheingans R, Kukla M, Adegbola R, et al. Exploring household economic impacts of childhood diarrheal illnesses in three African settings. *Clin Infect Dis*. 2012; 55(S4):S317–26.
 105. Rheingans R, Kukla M, Faruque A, et al. Determinants of household costs associated with childhood diarrhea in three South Asian settings. *Clin Infect Dis*. 2012; 55(Suppl 4):S327–35.
 106. Anh DD, Riewpaiboon A, Tho LH, et al. Treatment Costs of Pneumonia, Meningitis, Sepsis, and Other Diseases among Hospitalized Children in Viet Nam. *J Health Population Nutrition*. 2010; 28(5):436-442.
 107. Madsen HO, Hanehøj M, Das AR, et al. Costing of severe pneumonia in hospitalized infants and children aged 2–36 months, at a secondary and tertiary level hospital of a not-for-profit organization. *Tropical Medicine and International Health*. 2009; 14(10):1315–1322.
 108. Alvis-Guzmana N, Orozco-Africano J, Paternina-Caicedo, et al. Treatment costs of diarrheal disease and all-cause pneumonia among children under-5 years of age in Colombia. *Vaccine* (2013), <http://dx.doi.org/10.1016/j.vaccine.2013.05.035>.
 109. Barnett I, Tefera B. Poor Households' Experiences and Perception of User Fees for Healthcare: a mixed-method study from Ethiopia. Working paper No. 59; published by Young Lives, June 2010.
 110. Federal Ministry of health of Ethiopia. 2005. Implementation manual for health care financing reforms. Addis Ababa, Ethiopia.

111. USAID Health Sector Financing Reform. 2013. The Status of Health Care Financing Reform in Ethiopia: Synthesis of data collected from health facilities through supportive supervision in year 2011/2012. Addis Ababa, Ethiopia.
112. Federal Democratic Republic of Ethiopia Ministry of health. April 2014. Ethiopia's Fifth National Health Accounts, 2010/2011. Addis Ababa, Ethiopia; Federal Ministry of Health.
113. Stanton B, Clemens J. User fees for health care in developing countries: a case study of Bangladesh. *Soc Sci Med* 1989; 29:1199–205.
114. Gelberg L, Andersen RM, Leake BD. The behavioral model for vulnerable populations: application to medical care use and outcomes for homeless people. *Health Serv Res* 2000; 34:1273–302.
115. Ridde V, Morestin F. A scoping review of the literature on the abolition of user fees in health care services in Africa. *Health Policy Plan* 2011; 26:1–11.
116. Admasu K, Tamire A, Tsegaye S. Envisioning the future of the health sector: an update. Federal Democratic Republic of Ethiopia Ministry of health Quarterly health bulletin. 2014; 6:1: 3-12.
117. Witter S, Babiker M. Ability to pay for health care in Khartoum State: results of a household survey. London: Save the Children, 2005.
118. World Health Organization. 2014. Making fair choices on the path to universal coverage; Final report of the WHO consultative group on equity and universal health coverage. Geneva: World Health Organization.
119. WHO, UNICEF, UNFPA, The World Bank, UN. 2014. Trends in maternal mortality: 1990 to 2013. Estimates by WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division. Geneva, Switzerland: WHO.
120. Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S. Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health policy and planning*. 2008; 23:101-17.
121. UNICEF, World Health Organization, The World Bank and United Nations. 2012. Levels and Trends in Child Mortality: Report 2012. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. New York, USA: UNICEF.
122. Adam T, Lim SS, Mehta S, Bhutta ZA, Fogstad H, Mathai M, et al. Cost effectiveness analysis of strategies for maternal and neonatal health in developing countries. *BMJ* 2005;331 doi: <http://dx.doi.org/10.1136/bmj.331.7525.1107>.
123. Becerra LC, Molina MG, Oviedo S, Urrego J, Rincón C, Rubio A, et al. Cost effectiveness of Calcium Supplement in reducing preeclampsia related maternal mortality. <http://ssrn.com/abstract:2194574> accessed on 02/11/2014.
124. Miller NP, Amouzou A, Bryce J, Victora C, Hazel E, Black RE. Assessment of iCCM implementation strength and quality of care in Oromia, Ethiopia.

-
- Baltimore, USA and Addis Ababa, Ethiopia: Institute for International Programs, Johns Hopkins Bloomberg School of Public Health; 2013.
125. Sloan NL, Ahmed S, Mitra SN, Choudhury M, Rob U, Winikoff B. Community-based kangaroo mother care to prevent neonatal and infant mortality: a randomized, controlled cluster trial. *Pediatrics*. 2008; 121:5, e1047-59.
 126. Traa BS, Walker CF, Munos M, Black RE. Antibiotics for the treatment of dysentery in children. *International Journal of Epidemiology*. 2010; doi:10.1093/ije/dyq024.
 127. Baqui AH, Arifeen SE, Williams EK, Ahmed S, Mannan I, Rahman SM, et al. Effectiveness of Home-based Management of Newborn Infections by Community Health Workers in Rural Bangladesh. *Pediatr Infect Dis J*. 2009;28:4: 304–10.
 128. Hu D, Grossman D, Levin C, Blanchard K, Adanu R, Goldie SJ, et al. Cost-effectiveness analysis of unsafe abortion and alternative first-trimester pregnancy termination strategies in Nigeria and Ghana. *African Journal of Reproductive health*. 2010;14:2: 85-103.
 129. Prevention of maternal mortality network. Abstracts from the PMM Results Conference. Center for Population and Family Health, School of Public Health, Faculty of Medicine, Columbia University, New York, 1997.
 130. Kruk ME, Paczkowski MM, Tegegn A, Tessema F, Hadley C, Asefa M, et al. Women’s preferences for obstetric care in rural Ethiopia: a population-based discrete choice experiment in a region with low rates of facility delivery. *J Epidemiol Community Health*. 2010; 64:984-8.
 131. Central Statistical Agency [Ethiopia]. 2014. Ethiopia Mini Demographic and Health Survey 2014. Addis Ababa, Ethiopia.
 132. Kerber KJ, Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet*. 2007; 370: 1358-69.
 133. Stenberg K, Axelson H, Sheehan P, Anderson I, Gülmezoglu AM, Temmaman M, et al. Advancing social and economic development by investing in women’s and children’s health: a new Global Investment Framework. *Lancet*. 2014;383:1333–54.
 134. Goldie SJ, Sweet S, Carvalho N, Natchu UCM, Hu D. Alternative Strategies to Reduce Maternal Mortality in India: A Cost-Effectiveness Analysis. *PLoS Med*. 2010; doi:10.1371/journal.pmed.1000264.
 135. United Nations Development Programme (UNDP). Human Development Report 2014.
 136. Pecenka CJ, Johansson KA, Memirie ST, et al. 2015. Health gains and financial risk protection: an extended cost-effectiveness analysis of treatment and prevention of diarrhoea in Ethiopia. *BMJ Open*; 5: e006402. doi:10.1136/bmjopen-2014-006402.

137. Johansson KJ, Memirie ST, Pecenka C, et al. Health gains and financial protection from pneumococcal vaccination and pneumonia treatment in Ethiopia: results from an extended cost-effectiveness analysis. PLoS ONE 2015; 10(12):e0142691.

Appendices



RESEARCH ARTICLE

Open Access



Inequalities in utilization of maternal and child health services in Ethiopia: the role of primary health care

Solomon Tessema Memirie^{1*}, Stéphane Verguet², Ole F. Norheim¹, Carol Levin³ and Kjell Arne Johansson¹

Abstract

Background: Health systems aim to narrow inequality in access to health care across socioeconomic groups and area of residency. However, in low-income countries, studies are lacking that systematically monitor and evaluate health programs with regard to their effect on specific inequalities. We aimed to measure changes in inequality in access to maternal and child health (MCH) interventions and the effect of Primary Health Care (PHC) facilities expansion on the inequality in access to care in Ethiopia.

Methods: The Demographic and Health Survey datasets from Ethiopia (2005 and 2011) were used. We calculated changes in utilization of MCH interventions and child morbidity. Concentration and horizontal inequity indices were estimated. Decomposition analysis was used to calculate the contribution of each determinant to the concentration index.

Results: Between 2005 and 2011, improvements in aggregate coverage have been observed for MCH interventions in Ethiopia. Wealth-related inequality has remained persistently high in all surveys. Socioeconomic factors were the main predictors of differences in maternal and child health services utilization and child health outcome. Utilization of primary care facilities for selected maternal and child health interventions have shown marked pro-poor improvement over the period 2005–2011.

Conclusions: Our findings suggest that expansion of PHC facilities in Ethiopia might have an important role in narrowing the urban-rural and rich-poor gaps in health service utilization for selected MCH interventions.

Keywords: Inequality, Maternal and child health services, Primary health care, Ethiopia

Background

There have been impressive increases in total coverage of essential child health services and child survival in developing countries over the last decades [1]. Even though equity has been stated as an important goal within health sectors, substantial disparities in coverage of maternal and child health services and in under-five mortality between rich and poor children have persisted in most low- and middle-income countries [2–5]. Inequalities across socioeconomic groups and by area of residence are important determinants of maternal and child health [6, 7].

Ethiopia has had a substantial progress in reducing under-five mortality rate (from 198 deaths per 1,000 live births in 1990 to 88 in 2011) [8, 9]. Despite gradual improvement in coverage of child health care services, inequality in child mortality and access to care between urban and rural dwellers and across wealth quintiles remain large. Under-five mortality is 114 deaths per 1,000 live births in rural areas and 83 deaths per 1,000 live births in urban areas. The poorest and the richest quintiles had an under-five mortality of 137 and 86 deaths per 1,000 live births, respectively. Among households with a child having either symptoms of pneumonia or diarrhea; 16 % and 22 % of households from the poorest quintile and 62 % and 53 % from the richest quintile sought care from a health care provider, respectively. The low service utilization occurred in the face of an

* Correspondence: solomon.memirie@igs.uib.no

¹Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway

Full list of author information is available at the end of the article



increased risk of diarrhea and pneumonia among children from the poorest quintile [9].

The national health policy of Ethiopia gives strong emphasis to fulfilling the needs of the rural residents, which constitute 84 % of the Ethiopian population. Ensuring universal access to health care is one of the main targets of the national Health Sector Development Program (HSDP) IV (2011–2015) in Ethiopia [10]. An accelerated expansion of primary health care (PHC) facilities [composed of health centers (HCs) and health posts (HPs)] has been undertaken since 2003. In nearly a decade, the number of HPs and HCs in Ethiopia grew by almost six fold to reach 3245 HCs and 16,048 HPs in 2012/2013. Each health post has two health extension workers (HEWs) and so far a total of 34,850 HEWs were trained and deployed nationally with a ratio to population of 1:2301 that surpassed HSDP III target of 1:2500 [10, 11]. The expansion is envisaged as the key strategy to deliver maternal, neonatal and child health interventions especially to the rural and impoverished segments of the population [12]. According to the 5th National Health Accounts in Ethiopia, 34 % of the total health expenditure was household out-of-pocket spending [13]. It is imperative that such expansions contribute to health equity primarily by moving towards universal access. The 2010 World Health Report has identified inefficient and inequitable use of resources as one of the factors that impede rapid movement towards universal health coverage (UHC) [14].

Inequalities in child health and child survival across household wealth quintiles were examined in the 2005 and 2011 Ethiopian Demographic Health Surveys (DHS) and by Barros et al. in their survey-based analysis of inequality in maternal and child health (MCH) in 54 countdown countries [9, 15, 16]. Skaftun et al. has also examined inequalities in child health in Ethiopia [17]. However, assessments done so far lack some critical MCH interventions (such as family planning) and morbidity outcomes (e.g. stunting) and are not examined in light of the rapid expansion of PHC facilities in Ethiopia. Additionally they did not take into consideration use relative to need, therefore were unable to assess inequity in MCH service utilization.

The main objectives of this study were: (1) to measure changes in degree of inequality in utilization of selected MCH interventions and child morbidities over time; (2) to determine factors associated with inequality and inequity in access to care; and (3) to assess the role of expansion of PHC facilities in Ethiopia on inequality and inequity in access to care using 2005 and 2011 DHS conducted in Ethiopia.

Methods

Data and variables definition

We used data from DHS conducted in Ethiopia in 2005 and 2011 [9, 15]. The 2005 and 2011 DHS were

conducted on a nationally representative sample of 9,861 and 11,654 households, respectively. The sampling design for both surveys was a two-staged stratified cluster sampling that was not self-weighted at national level. The survey participants/households were stratified into urban or rural groups according to their area of residence. Household's socioeconomic status was measured using household asset data via a principal components analysis. We used the wealth quintiles as a living standard measure in the subsequent modeling.

Utilization of MCH services was selected for analysis. These were binary variables, where a value of 1 was assigned if care was accessed or a value of 0 if care was not accessed. Both prevention and treatment services were included, where we looked at: medical treatment for diarrhea, skilled birth attendance (SBA), measles immunizations and modern contraceptive usage. We used prevalence of diarrhea, cough, fever and stunting in children as morbidity variables.

Analysis

Inequality in outcomes was measured by calculating a concentration index, where this index quantifies the magnitude of wealth-related inequality that can be compared conveniently across time periods, countries, regions, or other comparators [18]. The paper by Wagstaff et al provides detailed description of concentration index [18]. In our analysis concentration index (C) was computed as twice the (weighted) covariance between the health variable (h) and the fractional rank of the person in the living standard distribution (r), divided by the mean of the health variable (μ) [19] as:

$$C = \frac{2}{\mu} Cov(h, r) \quad (1)$$

Concentration index is restricted to values between -1 and 1 and has a value of zero where there is no income-related inequality in outcomes. If the variable reflects morbidity or mortality, the concentration index will usually be negative, showing that ill health is more prevalent among the poor. For coverage indicators, the concentration index is usually positive, as these tend to be higher among the rich [19].

Even though concentration index is a measure of income-related inequality in health care utilization, it does not measure the degree of inequity in use since it still includes legitimate income-related differences in use due to differences in need. Therefore, in our analysis, standardization for differences in need for health care in relation to wealth was done using the method of indirect standardization. Standardization adjusts for the need expected distribution as opposed to the observed distribution of use [20]. To proxy need in health care, the

following demographic and morbidity variables were used: age and sex of children under-five years of age and age of women in the reproductive age group (as demographic variables), recent episode of diarrhea (as a morbidity variable in children), history of birth in the past five years (as a proxy of need for SBA) and unmet need for family planning (as a need variable for modern contraceptive usage). Wealth quintile, educational attainment of household head, educational attainment of partner, and area of residence were used as non-need correlates of health care utilization (control variables). Only 0.5 % of the households had health insurance coverage, therefore we did not use it as one of the control variable in our analysis [9].

After estimating the need-standardized utilization, inequity can be tested by determining whether standardized use is unequally distributed across wealth quintiles. Inequity could be measured by estimating the concentration index of need-standardized health care utilization, which is denoted as the health inequity index. Alternatively, the health inequity index can be calculated as a difference between the concentration index for actual utilization and need-expected utilization of medical care [20]. A positive (negative) value of horizontal inequity index indicates horizontal inequity that is pro-rich (pro-poor), while an index value of zero shows absence of horizontal inequity.

The decomposition of the concentration index allows the measurement and explanation of inequality in utilization of health care services across income groups. Wagstaff et al [21] has demonstrated that for any linear regression model of a variable, such as health care use, it is possible to decompose the measured inequality into the contribution of explanatory factors. With this decomposition approach, standardization for need as well as explanation of inequity can be done in one step. Consider the following model:

$$y_i = \alpha + \sum_j \beta_j x_{ji} + \sum_k \beta_k z_{ki} + \varepsilon_i, \tag{2}$$

, where x_j denotes the need standardizing variables, that includes demographic and health status/morbidity factors, and z_k denotes the non-need variables including socioeconomic status, education, area of residence (urban vs. rural). α , β and ε are the constant, regression coefficients and the error term respectively. The concentration index (C) for utilization of health care can then be written as:

$$C = \sum_j (\beta_j \bar{x}_j / \mu) C_j + \sum_k (\beta_k \bar{z}_k / \mu) C_k + {}^G C_u / \mu, \tag{3}$$

, where C_j and C_k are the concentration indices for the need and non-need variables respectively while μ is the mean of our health variable of interest (y), \bar{x}_j is the mean of x_j and

\bar{z}_k is the mean of z_k . The components $(\beta_j \bar{x}_j / \mu)$ and $(\beta_k \bar{z}_k / \mu)$ are simply the elasticity of y with respect to x_j and z_k , respectively, that are evaluated at the sample mean.

The last term in the equation $({}^G C_u / \mu)$ captures the residual component that reflects the inequality in health that is not explained by systematic variation across income groups in the need and non-need variables.

Decomposition for non-linear models can only be applied using linear approximation which can introduce errors and is complex. Therefore, even if our health variable of interest is a binary variable, we used the linear model. It has been found elsewhere that decomposition results differ little between ordinary least squares and non-linear estimators [22].

Time trends for changes in mean levels of MCH service utilization were assessed using logistic regression model. MCH service utilizations were used as dependent variables while time of survey as independent variables. We computed the percentage change in excess risk by subtracting one from rate ratio (rate ratio-1), where rate ratio is the incidence in the poorest quintile divided by incidence in the richest quintile (Q1/Q5) [23].

Data were analyzed using the statistical software package STATA (version 13), taking into account the sampling design characteristics of each survey.

Ethical considerations

We did the analyses using publicly available data from demographic health surveys. Ethical procedures were the responsibility of the institutions that commissioned, funded, or managed the surveys. The study was approved by Regional committees for medical and health research ethics (REK) in Norway and Ethiopian Health and Nutrition Research Institute (EHNRI) scientific and ethical review committee.

Results

Utilization of measles immunization and modern contraceptive methods has on average increased between 2005 and 2011 (Table 1). Pro-poor coverage changes with a clear dominance were observed for both interventions, demonstrated by significantly (non-overlapping 95 % CI) lower concentration indices in 2011 as compared to 2005. Use of modern contraceptive methods had the widest coverage gap between the poorest and wealthiest in all surveys. In 2011, modern contraceptive methods use rates were 6 % and 44 % for the poorest and the wealthiest quintiles, respectively.

Prevalence of diarrhea and stunting has decreased between 2005 and 2011 survey years (Table 1). The concentration indices for all morbidities are negative, indicating a higher burden among children from poor households. The inequality across wealth strata was highest for the

Table 1 Average, first and fifth quintile values and concentration indices of selected maternal and child health indicators in Ethiopia (DHS: 2005 and 2011)

Variables	Average value (%)		Lowest quintile value (%)		Highest quintile value (%)		Concentration index (95 % CI)	
	2005	2011	2005	2011	2005	2011	2005	2011
Year of DHS								
Health service utilization:								
Measles immunization	34.9	55.7*	24.9	45.3	52.5	79.7	0.113 (0.096–0.130)	0.085 (0.074–0.096)
Use of modern contraceptive method ^a	17.4	18.7*	2.6	6.4	36.0	43.5	0.405 (0.369–0.441)	0.275 (0.247–0.303)
Morbidity:								
ARI prevalence in children <5 years	15.9	19.7*	14.8	20.7	13.5	17.0	-0.004 ((-0.015)–0.023)	-0.010 ((-0.048)–0.049)
Diarrhea prevalence in children <5 years	17.2	15.0*	15.6	16.2	14.1	11.3	-0.037 ((-0.067)–(-0.007))	-0.029 ((-0.117)–0.059)
Fever prevalence in children <5 years	17.6	19.3**	16.3	21.5	15.2	16.5	-0.025 ((-0.076)–0.026)	-0.025 ((-0.099)–0.049)
Prevalence of Stunting in children <5 years	47.0	44.0*	49.9	47.2	38.4	27.6	-0.026 ((-0.040)–(-0.012))	-0.048 ((-0.062)–(-0.038))

Note: *Indicate the p-value for trend over the period 2005 and 2011 is <0.001. **Indicate the p-value for trend over the period 2005 and 2011 is <0.05. ^aAll women aged 15–49 is used as the denominator

prevalence of stunting. The excess risk of the poorest quintile relative to the wealthiest quintile for having Acute Respiratory Infection (ARI), diarrhea, fever or stunting is 22 %, 43 %, 30 % and 71 %, respectively. The inequality in the rate of stunting has widened over the period 2005–2011.

The last row of table 2 shows the values of health inequity indices, calculated as the difference between the actual (the unstandardized concentration indices presented as “Total” in the table) and the contribution of all need factors to the concentration indices. The contribution of need factors to concentration index is negative for SBA (-2.1 %) and modern contraceptives (-1.4 %) suggesting that if utilization of these services were determined by need alone it would be pro-poor. In our case,

the contribution of need factors to concentration index and their effect on health inequity index is very low highlighting the difficulty to define need for the interventions included in the analysis.

The health inequity index is positive for all interventions, indicating that for a given need, children and women from wealthier households make greater use of available services in Ethiopia. Decomposition of the concentration index shows that 47 %, 66 %, 76 % and 85 % of wealth-related inequality in access to SBA, medical treatment for diarrhea, modern contraceptive use, and measles vaccination respectively is explained by the direct effect of household economic status and by educational attainment of parents. Area of residence

Table 2 Decomposition of the concentration indices for access to selected maternal and child health interventions in Ethiopia, 2011

	Contribution of need and non-need factors to the concentration indices for access to MCH care							
	Medical treatment for Diarrhea		Skilled birth attendance		Measles immunization		Modern Contraceptive	
	Absolute	%	Absolute	%	Absolute	%	Absolute	%
Need factors								
Demographic	0.0002	0.1	-0.0079	-1.1	0.0012	1.4	-0.0038	-1.4
Health status	0 ^a	0.0	-0.0072	-1.0	-	-	0.0000	0.0
Subtotal	0.0002	0.1	-0.0151	-2.1	0.0012	1.4	-0.0038	-1.4
Non-need factors								
Wealth index	0.0510	33.5	0.1162	15.9	0.0578	68.2	0.1605	58.4
Educational attainment (women)	0.0294	19.3	0.1779	24.4	0.0175	20.7	0.0449	16.4
Educational attainment (men)	0.0205	13.4	0.0510	7.0	-0.0033	-3.8	0.0021	0.8
Area of residence (rural)	0.0158	10.4	0.2984	40.9	-0.0019	-2.3	0.0265	9.7
Subtotal	0.1097	77.0	0.6434	88.2	0.0702	82.8	0.2341	85.2
Residual	0.0355	22.8	0.1015	13.9	0.0134	15.8	0.0443	16.1
Total	0.1523		0.7299		0.0847		0.2747	
Horizontal inequity index	0.1521		0.7450		0.0835		0.2784	
Adjusted R ²	0.05		0.35		0.13		0.21	

Note: ^aOmitted from the analysis as recent episode of diarrhea was highly correlated with medical care seeking

contributes to large proportion (41 %) of the inequality in access for SBA to the disadvantage of the rural households. The elasticity of SBA with respect to women's age and number of births (by a woman in the last five years) were both negative indicating that with increasing maternal age and birth order, the probability of birth attendance by a skilled professional decreases. On the contrary, for women in their reproductive age, the probability of using modern contraceptives on average increases with women's age.

In order to assess the role of PHC expansion on changes in inequality in the utilization of MCH services, we used data on type of facility for diarrhea treatment, source for modern contraceptives and place of delivery. Utilization of services for diarrhea treatment, modern contraceptives and facility delivery in Ethiopia, on average, has improved over the period 2005–2011. Government PHC facilities played the major role for the improvement (Table 3). The contribution of PHC facilities as a point of care for diarrheal treatment, as source of contraceptives and place of delivery rose from 67 %, 74 % and 32 % in 2005 to 74 %, 85 % and 47 % in 2011 respectively. The lower

socioeconomic groups are more likely to seek government PHC facilities as a source of modern contraceptive, as indicated by the negative concentration and health inequity indices (see Table 3). Even though concentration and health inequity indices for diarrhea treatment are positive for 2005 and 2011, both have shown a significant pro-poor improvement over the period 2005–2011. For all services, those with high socioeconomic status are more likely to report a visit to private facilities and the gap in private care utilization across socioeconomic groups has widened over time.

Discussion

Despite improvements in coverage of MCH services, the inequality by wealth quintile has remained persistently high in all surveys. Socioeconomic status, measured by a wealth index and parental educational attainment, were the main predictors of differences in utilization of MCH services and health outcomes in children under five years of age. Area of residence has been a significant contributor for the disparity in access to SBA.

Table 3 Wealth related inequality and inequity in health care service utilization for diarrheal treatment, modern contraceptives and place of delivery by type of facility

	2005				2011			
	% using the service	Contribution (%)	Concentration index (95 % CI)	Horizontal inequity index	% using the service	Contribution (%)	Concentration index (95 % CI)	Horizontal inequity index
Diarrhea treatment								
Government hospital	4.7	21.9	0.069 (−0.220–0.358)	0.085	0.7*	2.0	0.347 (0.048–0.645)	0.353
Government PHC ^a	14.3	66.5	0.191 (0.111–0.270)	0.197	23.6*	73.5	0.094 (0.022–0.167)	0.091
Private facilities	2.5	11.6	0.140 (0.030–0.277)	0.151	7.9*	24.4	0.262 (0.100–0.424)	0.274
Total	21.5	100			32.1	100		
Source of Modern contraceptive								
Government hospital	0.8	4.5	0.616 (0.336–0.897)	0.577	0.3*	1.7	0.484 (0.229–0.739)	0.485
Government PHC ^a	12.9	74.4	−0.080 (−0.103)–(−0.057))	−0.083	15.9*	84.9	−0.071 (−0.089)–(−0.054))	−0.071
Private facilities	2.7	15.7	0.171 (0.101–0.241)	0.183	1.9*	10.3	0.398 (0.269–0.528)	0.395
Other	0.9	5.4	0.095 (−0.188)–0.186)	0.130	0.6**	3.1	0.359 (0.030–0.690)	0.373
Total	17.4	100			18.7	100		
Place of Delivery								
Government hospital	3.0	52.6	0.829 (0.761–0.896)	0.854	3.8*	37.8	0.792 (0.720–0.864)	0.815
Government PHC ^a	1.8	31.6	0.735 (0.637–0.834)	0.745	4.7*	47.1	0.670 (0.588–0.752)	0.702
Private facilities	0.9	15.8	0.487 (0.281–0.692)	0.433	1.5**	15.1	0.691 (0.575–0.809)	0.679
Total	5.7	100			10.0	100		

Note: *Indicate the p-value for trend over the period 2005 and 2011 is <0.01. **Indicate the p-value for trend over the period 2005 and 2011 is >0.05. ^aPHC denotes primary health care facilities that include health centers, health stations and health posts

Among the health service coverage indicators (2011 DHS), use of modern contraceptive methods was the most inequitably distributed interventions, with a horizontal inequity index of 0.28. The average concentration index for 54 countdown countries for family planning needs satisfied was 0.14 (IQR: 0.05–0.2), making Ethiopia one of the countries with the most unequal distribution of the service [16]. Wealth level and educational attainment of women are estimated to jointly contribute to 75 % of this inequity in use of contraceptive methods. Several studies have demonstrated wealth and parental educational attainment as major determinants of access to MCH services in Sub-Saharan African countries [24, 25].

Albeit the low coverage of measles immunization in Ethiopia, it was the most equitably distributed indicator with a horizontal inequity index of 0.08 in 2011 DHS and it has shown a significant pro-poor improvement in comparison to 2005 DHS finding. The pro-poor improvement in measles immunization might be related to the “follow-up” measles vaccination campaigns conducted in Ethiopia. The low measles immunization coverage with marked heterogeneity by geographic location threatens the goals set out for elimination of measles at national and global levels [26].

The PHC service in Ethiopia is organized to deliver a package of basic preventive and curative health services targeting rural households. It is comprised of the following four health subprograms that conform to the elements of PHC as defined in the Alma Ata Declaration [27]: hygiene and environmental sanitation, disease prevention and control, health education and communication and family health (that include MCH, vaccination and family planning services).

PHC facilities have played an increasingly important role as points of care for diarrhea treatment and as a source of modern contraceptive for the less privileged socioeconomic group. Several studies have documented the effect of a scale up and equitable distribution of primary health care infrastructure and intervention coverage on inequality in service utilization and child health outcomes among different socioeconomic groups [23, 28, 29]. The role of PHC facilities as points of delivery care services in Ethiopia is relatively low. Public hospitals and private facilities play a major role as delivery care services outlet, more so for the wealthiest quintile and urban residents. The low utilization of these services among the poor and rural residents might be related to out-of-pocket spending by families, either for services or because families need to travel to a health facility. In countries where maternity hospitals are accessible and free of charge, coverage for SBA is almost universal [16]. Quality of care is an important aspect in utilization of delivery care services. The 2008 National baseline

assessment for emergency obstetric and neonatal care has identified critical gaps in the delivery of quality obstetric and neonatal care in Ethiopia [30]. A study conducted in Ethiopia has also shown that women in rural Ethiopia strongly preferred health facility attributes indicative of good technical quality, reliable supply of medicines, functioning equipment and respectful provider attitude in selecting a delivery facility [31]. MCH services are among those services that suffer from inadequate resource allocation compromising delivery of quality services [10]. Cultural factors also influence utilization of facility delivery care service. According to 2011 Ethiopian DHS, 31 % of rural women reported that facility deliveries were not customary [9].

This study has some limitations. Recall bias is one possible problem in surveys as they are based on maternal recall. Differential reporting by rich and poor mother's and between urban and rural residents is also a concern for a possible bias. The other limitation is that associated with asset indices. We have observed that the wealthiest quintile tend to reside in urban areas, particularly in the capital city, so that wealth inequities are closely associated with urban/rural disparities. In our analysis, the contribution of need factors to the horizontal inequity index was negligible. This could lead to a biased measurement of horizontal inequity index if there were other need factors (which we failed to include) that vary with income. Additionally, in the computation of concentration indices for binary outcomes, we used a linear regression model that may lead to inaccuracies.

Despite these limitations, our study adds important findings to the existing body of literature. The study included critical MCH interventions (such as family planning) and morbidity outcomes (for example, stunting) not addressed elsewhere. More importantly, we tried to assess if PHC expansion had any effect on inequality and inequity in access to care. The expansion of PHC facilities seems to have contributed positively to the coverage changes and the pro-poor and pro-rural improvements even though other factors (such as women's education, safe water supply, food security) might have contributed as well. The 2008 World Health Report has reaffirmed the role of PHC as a pathway to achieve UHC and as a core strategy for health systems strengthening [32]. The new global investment frame work for Women's and Children's Health [33] has shown the substantial economic and social benefits of investing in Reproductive, Maternal, Neonatal and Child Health interventions. Nearly half of the reduction in child and maternal deaths was estimated to result from greater access to contraceptives for effective family planning that can be scaled-up at a relatively small cost using PHC as a delivery platform. The expected demographic dividend from the reduction in unintended pregnancy was estimated to

exceed 8 % of the Gross Domestic Product by 2035 in countries with high fertility rate like Ethiopia. Further reduction in maternal and child mortality requires ensuring a reliable access to an integrated antenatal, intrapartum and postpartum care by skilled attendants [33, 34].

Conclusions

While great progress has been made in Ethiopia, this analysis demonstrates that there is continued room for improvement to address persistently high inequality across the socio-economic spectrum. Future plans should aim to sustain current successes in health system strengthening and to bring these benefits to all women and children, particularly to those socioeconomically marginalized and rural residents. In addition to continued improvements to Ethiopia's health sector, investments in women's education and implementing pro-poor policies will be critical to maximize equitable health gains and population wide benefits. Monitoring the progress of intervention implementation should have an equity perspective.

Abbreviations

ARI: acute respiratory infection; CI: concentration indices; DHS: demographic health survey; HCs: health centers; HEWs: health extension workers; HPs: health posts; HSDP: health sector development program; MCH: maternal and child health; PHC: primary health care; SBA: skilled birth attendant; UHC: universal health coverage.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

STM, KAJ and OFN initiated and conceptualized the study. STM coordinated the research and did the analysis with KAJ and OFN. STM wrote the first draft of the manuscript. KAJ, OFN, SV, and CL reviewed the manuscript and provided advice and suggestions. STM had final responsibility to submit for publication. All authors read and approved the final manuscript.

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Author details

¹Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway. ²Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Boston, MA, USA. ³Department of Global Health, University of Washington, Seattle, WA, USA.

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References

1. Victora CG, Barros AJD, Axelson H, Bhutta ZA, Chopra M, França G, et al. How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet*. 2012;380:1149–56.
2. Gwatkin D, Rutstein S, Johnson K, Suliman E, Wagstaff A, Amozou A. Initial country-level information about socioeconomic differences in health, nutrition, and population. Washington: The World Bank; 2007.
3. Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG. Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet*. 2008;371:1259–67.
4. Moser KA, Leon DA, Gwatkin DR. How does progress towards the child mortality millennium development goal affect inequalities between the poorest and least poor? Analysis of Demographic and Health Survey data. *BMJ*. 2005;331(7526):1180–2.
5. Victora CG, Wagstaff A, Schellenberg JA, Gwatkin D, Claeson M, Habicht JP. Applying an equity lens to child health and mortality: more of the same is not enough. *Lancet*. 2003;362(9379):233–41.
6. Fotso JC. Child health inequities in developing countries: differences across urban and rural areas. *Int J Equity Health*. 2006;11:5–9.
7. Kakazo M, Lehmann D, Coakley K, Gratten H, Saleu G, Taime J, et al. Mortality rates and the utilization of health services during terminal illness in the Asaro Valley, Eastern Highlands Province, Papua New Guinea. *P N G Med J*. 1999;42:13–26.
8. UNICEF, World Health Organization, The World Bank and United Nations. Levels and Trends in Child Mortality: Report 2012. 2012. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. UNICEF; 2012.
9. Central Statistical Agency [Ethiopia] and ICF International. Ethiopia Demographic Health Survey 2011. Addis Ababa and Calverton Maryland: Central Statistics Agency and ICF International; 2012.
10. Federal Democratic Republic of Ethiopia Ministry of health. Health Sector Development Program IV (2010/2011–2014/2015). 2010.
11. Federal Ministry of Health (Ethiopia). Health and Health related indicators 2005 E.C. (2012/2013). 2014.
12. Federal Ministry of Health of Ethiopia. Health Extension Implementation Guide. Addis Ababa: Health Extension Education Center; 2007.
13. Ethiopia Federal Ministry of Health. April 2014. Ethiopia's Fifth National Health Accounts 2010/2011. Addis Ababa, Ethiopia
14. World Health Organization. 2010. The World Health Report. Health systems financing: the path to universal coverage. Geneva: World Health Organization; 2010.
15. Central statistical agency [Ethiopia] and ICF International. Ethiopia Demographic Health Survey 2005. Addis Ababa and Calverton, Maryland: Central Statistical Agency and ICF International; 2006.
16. Barros AJD, Ronsmans C, Axelson H, Loaiza E, Bertoldi A, França G, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet*. 2012;379:1225–33.
17. Skafun EK, Ali M, Norheim OF. Understanding inequalities in Child Health in Ethiopia: Health Achievements Are Improving in the Period 2000–2011. *PLoS ONE*. 2014; doi:10.1371/journal.pone.0106460
18. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med*. 1991;33(5):545–57.
19. O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Analysing health equity using household survey data: a guide to techniques and their implementation. Washington, D.C.: The World Bank; 2008.
20. van Doorslaer E, Koolman X, Jones AM. Explaining income-related inequalities in doctor utilization in Europe. *Health Econ*. 2004;13:629–47.
21. Wagstaff A, van Doorslaer E, Watanabe N. On decomposing health sector inequalities, with an application to malnutrition inequalities in Vietnam. *J Econometrics*. 2003;112:219–27.
22. Van Doorslaer E, Masseria C. The OECD Health Equity Research Group. Income related inequality in the use of medical care in 21 OECD countries. In OECD, Towards high performing health systems. Paris: Head of Publication Services OECD; 2004.
23. Vapattanawong P, Hogan MC, Hanvoravongchai P, Gakidou E, Vos T, Lopez AD, et al. Reductions in child mortality levels and inequality in Thailand: analysis of two censuses. *Lancet*. 2007;369(9564):850–5.
24. Van Malderen C, Ogali I, Khasakhala A, Muchiri SN, Sparks C, Van Oyen H, et al. 2013. Decomposing Kenyan socioeconomic inequalities in skilled birth Attendance and measles immunization. *International Journal for Equity in Health*. 2013; doi: 10.1186/1475-9276-12-3.
25. Adewemimo AW, Msuya SE, Olaniran CT, Adegoke AA. Utilization of skilled birth attendance in Northern Nigeria: A cross-sectional survey. *Midwifery*. 2014;30:e7–e13.
26. World Health Organization. Global Vaccine Action Plan 2011–2020. Geneva: World Health Organization; 2013.
27. WHO (World Health Organization). 1978. "Declaration of Alma-Ata." International Conference on Primary Health Care, Alma-Ata, September 6–12. http://www.who.int/publications/almaata_declaration_en.pdf. Accessed 30 Nov 2015.
28. Macinko J, Guanais FC, de Fatima M, de Souza M. Evaluation of the impact of the family health program on infant mortality in Brazil, 1990–2002. *J Epidemiol Community Health*. 2006;60(1):13–9.

29. Masanja H, Schellenberg JA, de Savigny D, Mshinda H, Victora CG. Impact of integrated management of childhood illness on inequalities in child health in rural Tanzania. *Health Policy Plan.* 2005;20 Suppl 1:77–84.
30. Federal Ministry of Health [Ethiopia], UNICEF, UNFPA, WHO and AMDD. National Baseline Assessment for Emergency Obstetric & Newborn Care Ethiopia. 2008.
31. Kruk ME, Paczkowski MM, Tegegn A, Tessema F, Hadley C, Asefa M, et al. Women's preferences for obstetric care in rural Ethiopia: a population-based discrete choice experiment in a region with low rates of facility delivery. *J Epidemiol Community Health.* 2010;64:984–8.
32. World Health Organization. World Health Report 2008: Primary health care – Now more than ever. Geneva: World Health Organization; 2008.
33. Stenberg K, Axelson H, Sheehan P, Anderson I, Gülmezoglu AM, Temmeman M, et al. Advancing social and economic development by investing in women's and children's health: a new Global Investment Framework. *Lancet.* 2014;383:1333–54.
34. Goldie SJ, Sweet S, Carvalho N, Natchu UCM, Hu D. Alternative Strategies to Reduce Maternal Mortality in India: A Cost-Effectiveness Analysis. *PLoSMed.* 2010; doi:10.1371/journal.pmed.1000264



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ETHIOPIAN HEALTH AND NUTRITION RESEARCH INSTITUTE
Addis Ababa, Ethiopia

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Ref. NO
ቀን 09 JUL 2013
Date

Dr. Solomon Tessema Memirie
Addis Ababa

Subject: Approval of Project Proposal

I would like to congratulate you and your group that your Research proposal entitled, "Scale up of high impact child intervention at community level in Ethiopia: equity, cost and cost-effectiveness analysis" has been examined and approved for its scientific and ethical merits by our Scientific and Ethical Review Committee.

Looking forward to seeing the best outcome of this work as a contribution to solving the health problem of our country, I wish you a successful implementation.



Sincerely Yours,

Amha Kebede
Amha Kebede (Dr)
Director General

C.C

D/Director General, RTT
Research Ethical Review Office
EHNRI

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You may Contact:

ፖ.ሣ.ቁ 1242/5654
P.O.Box

ስልክ 011-2754647
TEL.

ፋክስ 251-11-2754744
Fax

E-mail amhak@ehnri.gov.et
<http://www.ehnri.gov.et/>

Annex 2:

Consent form

Scale up of high impact child health interventions at community level in Ethiopia: cost, cost effectiveness and equity impact analyses

Request of participation

Getting access to health institution for diagnosis and management of childhood illnesses could be expensive and difficult especially for the rural poor becoming a formidable obstacle to seek a life saving treatment for the sick child or neonate. This requires alternative mechanisms to make diagnosis and treatment of childhood illnesses accessible to the majority of Ethiopian children.

Our study aims to assess the cost, cost effectiveness and equity impact of scaling up of selected child health interventions using community health workers. This will help to generate evidence on community case management of common childhood illnesses to facilitate evidence based decision making by decision makers in Ethiopia.

If interventions are delivered at the community level they will be easily accessible to the majority of the population especially to those living in rural parts of the country. There is no obligation and related punishment in case you do not like to take part in the study. Your participation in the study is fully based on voluntary decision. You have the right to participate and withdraw from the study. Your refusal not to participate in the study will not affect the treatment the child receives.

In case of inconveniences or for more information, you can contact Dr. Solomon Tessema by using the following address:

P.O. Box 121260

Addis Ababa

Tele. +251 911 403936

Individual consent form: Scale up of high impact child health interventions at community level in Ethiopia: cost, cost effectiveness and equity impact analyses

Purpose of the study: you are invited to join the study because your child or the child you are taking care of has one of the following (pneumonia, diarrhoea, malaria or neonatal sepsis) . The purpose of this study is to find out what extra money and time you and your family had to spend to visit a health facility in order to receive care for the illness the child has. You are randomly selected to participate in this study.

What participation involves: you are free to decide to participate in the study. We will ask you some questions about the child's illnesses, costs that you incur for seeking care for the child. It may take about 20 minutes to go through the interview.

Confidentiality: all information collected from you will be kept confidential and will not be disclosed to others. It will only be used for the purpose of the study.

Risks: We do not expect any risk in participating in the study.

Rights to withdraw and alternatives: Taking part in the study is completely your choice. You can decide not to participate in the study therefore refuse the interview at any time even after starting it. Deciding not to participate in the study will not affect the treatment the child receives.

Benefits: the anticipated benefit of participating in the study is that it will help generate valuable information on community level management of childhood illnesses that will help future decisions by health decision makers in Ethiopia.

Who to contact if you have any question you can contact Dr. Solomon Tessema, the principal investigator.

Do you have any question?

I, _____ have read and clearly understood the contents of this form. My questions have been answered. I agree to participate in the study.

Signature of the participant

Signature of the research assistant

Date

Date

**HOUSEHOLD ECONOMIC COSTS OF TREATING COMMON CHILDHOOD
ILLNESSES (PNEUMONIA AND DIARRHEA) IN ETHIOPIA.**

FACILITY EXIT INTERVIEW QUESTIONNAIRE.

Informant consent form

Dear Participant,

As a caretaker of this child, you are selected to be included in this interview. We would like to find out what extra money and time you and your family had to spend to visit the (*specify location*). Your answers are important because they will give those who make decisions about patient treatment within the National Health Service an idea of how much it costs you to use health services. The information will help the government to plan health services in the future. I would like to ask you some questions about the costs incurred for the health care services for your child's illness. The questions usually take about 30 minutes. The information that you provide will be completely confidential. Your answers will be combined with the answers of other patients involved in the study and reported in such a way that it will not identify you or influence your child's pattern of treatment. If you agree to answer the questions then we will proceed with the interview but you can decide not to participate in the interview. If I ask you any question you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time.

If you would like any further information about this study please contact Dr. Solomon Tessema on: 0911403936.

Do you have any questions?

May I begin the interview now?

Respondent agrees to be interviewed...1

Respondent does not agree to be interviewed...2

Signature of Respondent: _____

Signature of interviewer: _____ Date: _____

0000 Address and type of health facility

This section asks about the address and the type of the health facility visited. Please fill the address of the facility in the space provided and select the best choice that describes the type of health facility visited.			
Q0001	Name of the health facility: _____		
Q0002	Region: _____	Q0003	Zone: _____
Q0004	District: _____		
Q0005	What is the type of the current health facility?	1=Public hospital 3=Private hospital 5=Health post	2=Public health center 4=Private clinic 6=Other, Specify

0010 Contact information and household size

We may call or visit you again to verify this interview or to collect additional information in the future. For this reason, I would like to have your name and address and contact details.						
Q0011	Patient/household ID	_ / _ / _				
Q0012	What is your full name? (Enter the name of the child's caretaker) Name and Father's name: _____					
Q0013	Where is residence of the child?	Urban 1	Rural 2 Do not Know 3			
Q0014	What is your address? Region District Kebelle	<table border="1" style="width: 100%;"> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> </table>				
Q0015	What is your telephone number? (if no telephone, leave blank) <table border="1" style="width: 100%; height: 20px;"> </table>					
Q0016	If we cannot contact you for whatever reason, could you tell us who we could contact, who will know how to get in touch with you?	Yes 1	No 2			
	What is this person's relationship to you? Name Relationship Telephone					
Q0017	What is Number of individuals living in the household where the child is living? Total number of individuals living in the household Total number of Adults living in the household Total number of children living in the household*	<table border="1" style="width: 100%;"> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> </table>				
*Children are those individuals who are members of the household and are under 15 years old.						

0020 Characteristics of the informant and other household members

	I will ask you the names of persons who usually live in the household where the child lives in order to determine the relationship of each person with the child. Do not forget to include yourself in the list. Record the informant/caretaker first on the list.						
List No.	A Name of the household member	B* What is the relationship of the informant and other household members to the child?	C** Sex	D Age in years	E*** Education: What is the highest level of school (name) has attended?	F**** Marital status: What is (name) current marital status?	G***** Employment status: What is (name) current employment status?
Q0020							
Q0021							
Q0022							
Q0023							
Q0024							
Q0025							
Q0026							
Q0027							
Q0028							
Q0029	Who is the person who provides the main economic support for the household? Record the "list No." of the person.			_____			
*Codes for B	1=Mother	2=Father	3=Sister	4=Brother	5=Uncle	6=Aunt	7=Other
**Codes for C	1=Male	2=Female					
***Codes for E	1=No Education	2=Some Primary Education	3=Completed Primary Education		4=Some Secondary Education		
	5=Completed Secondary Education	6=More than Secondary Education		7=Do not Know			
****Codes for F	1= Married	2=Living together	3=Separated/Divorced		4=Widowed		
	5=Never married and never lived together						
***** Codes for G	1=In full time work	2=In Part time work	3=Currently seeking work		4=Housewife		
	5=Retired		6=Do not Know				

0030 Age and sex of the child

Q0030	Is (name of the child) male or female?	1=Male	2=Female				
Q0031	What is (name)'s birth date?	Day:	<table border="1"> <tr> <td></td> <td></td> <td></td> </tr> </table>				
		Month:	<table border="1"> <tr> <td></td> <td></td> <td></td> </tr> </table>				
		Year:	<table border="1"> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </table>				

0040 Description of health care visit

I will ask you about the illness the child has and the type and frequency of health facility visits for the current illness of the child.			
Q0040	What illness does the child have for the current visit (use the diagnosis made by the clinician)?	1=Pneumonia 2=Diarrhea without blood 3=Dysentery 4=Severe diarrhea with in-patient care 5=Severe pneumonia with in-patient care	
Q0041	Is this your first visit to any health facility for the current illness?	1=Yes 2=No	If "No", go to Q0042. If "Yes" skip Q0042
Q0042	How many times have you visited a health facility for the current illness?	_____ times	
Q0043	Was the child admitted to the hospital or clinic for the current illness?	1=Yes 2=No	If "Yes", go to Q0044. If "No" skip Q0044
Q0044	How long did he stay in the hospital or the clinic? (Specify in days if the child has stayed more than 24 hours, otherwise specify in hours).	_____ Days _____ Hours	

Q0050 Caretakers and Patient travel costs

I will ask you about the costs of your traveling to health facilities visited for the current illness the child has							
No.	A*	B ⁺	C [⊥]	D [£]	E [¥]	F [£]	G ^Ω
	Visit type	What transport modality have you used to travel from home to health facility (H→F)?	How much cost have you incurred to travel from H→F?	What is the distance travelled from H→F?	What transport modality have you used or intend to use for return trip?	How much cost have you incurred or will you incur for return trip?	What is the distance traveled or that you will travel for return trip?
Q0050	First visit		_____	_____ km		_____	_____ km
Q0051	Second visit		_____	_____ km		_____	_____ km
Q0052	Third visit		_____	_____ km		_____	_____ km
Q0053	Fourth visit		_____	_____ km		_____	_____ km
Q0054	Fifth visit		_____	_____ km		_____	_____ km
*A: This may be the first or subsequent visit to the health facility for the current illness the child has. Depending on the number of visits to the health facility please fill each row appropriately.							
⁺ B: Please put the number that best describes how the child and caretaker/s travelled from H→F. If they used more than one form of transport, please indicate the main way of travel (longest in terms of distance). Use one of the following codes: 1=Walked 2=Cycled 3=Bus 4=Minibus 5=Taxi 6=Private car 7=Motorbike 8=Hospital car 9=Ambulance 10=Other							
[⊥] C: If they travelled by bus, minibus or taxi for part or the entire journey, please enter the cost of one way fare in the space for the appropriate visit type. Put zero if they did not travel by bus, minibus or taxi or if they did not pay a fare.							
[£] D: If they travelled by private car or motorbike, please write the number of kilometer in the space for the appropriate visit type. Put zero if they did not travel by private car or motorbike at all.							
[¥] E: Please put the number that best describes how the child and caretaker/s travelled or intended to travel the return trip. If they used or intend to use more than one form of transport, please indicate the main way of travel (longest in terms of distance). Use one of the following codes: 1=Walked 2=Cycled 3=Bus 4=Minibus 5=Taxi 6=Private car 7=Motorbike 8=Hospital car 9=Ambulance 10=Other							
[£] F: If they travelled or intend to travel by bus, minibus or taxi for part or the entire journey, please enter the cost of one way fare in the space for the appropriate visit type.							
^Ω G: If they travelled or intend to travel by private car or motorbike, please write the number of kilometer in the space for the appropriate visit type.							

Q0060 Caretaker/s time costs

I will ask you about the time that you have spent with the child in health facilities for the current illness the child has. The time includes: travel time to facility, waiting time in the facility and time spent with the clinician/s.

No.	A*	B [†]	C [‡]	D [†]	E [‡]
	Visit type	What is the time that you (first caretaker) have spent with the child for this health facility visit?	What is your (first caretaker) main activity?	What is the time that you (second caretaker) have spent with the child for this health facility visit?	What is your (second caretaker) main activity?
Q0060	First visit	___ Days ___ hours ___ minutes		___ Days ___ hours ___ minutes	
Q0061	Second visit	___ Days ___ hours ___ minutes		___ Days ___ hours ___ minutes	
Q0062	Third visit	___ Days ___ hours ___ minutes		___ Days ___ hours ___ minutes	
Q0063	Fourth visit	___ Days ___ hours ___ minutes		___ Days ___ hours ___ minutes	
Q0064	Fifth visit	___ Days ___ hours ___ minutes		___ Days ___ hours ___ minutes	

*A: This may be the first or subsequent visit to the health facility for the current illness the child has. Depending on the number of visits to the health facility please fill each row appropriately.

[†]: Please write the number of hours and minutes that the caretakers has spent traveling to the facility, waiting at the facility including time spent with the clinician/s (doctor, nurse, health extension worker). If only one caretaker fill in the space provided for the first caretaker. If two caretakers, then for the primary caretaker use the space provided for the first caretaker and for the second caretaker use the space provided for the second care taker. If more than two care takers, select the two main caretakers and fill the space accordingly. If the child is admitted the time spent by the caretaker to take care of the child should also be included.

[‡]: Please put the number that best describes what would the caretaker otherwise have been doing as his/her main activity if she/he had not come to the facility. Use one of the following codes:

- | | | | |
|--------------------|----------------------------------|-----------------------------------|------------------|
| 1=Housework | 2=Childcare | 3=Caring for a relative or friend | 4=Voluntary work |
| 5=Leisure activity | 6=Attending school or university | 7=On Sick leave | 8=Seeking work |
| 9=Paid work | 10=Other | | |

Q0070 Costs incurred for health care services and medications

I will ask you about the costs that you have incurred for health care services in health facilities that you have visited so far for treatment of the child for his/her current illness. Costs incurred may include registration/consultation fee, laboratory and other medical investigations and drug costs.

No.	A* Visit type	B [€] How much cost have you incurred for Registration/ Consultation?	C [©] How much cost have you incurred for Laboratory/ Medical investigation?	D [‡] How much cost have you incurred for Prescribed medications?	E [#] How much cost have you incurred for hospital beds?	F [®] How much cost have you incurred for medications purchased without prescriptions?	G ^α How much any other cost have you incurred?
Q0070	First visit	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____
Q0071	Second visit	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____
Q0072	Third visit	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____
Q0073	Fourth visit	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____
Q0074	Fifth visit	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____	Birr_____

*A: This may be the first or subsequent visit to the health facility for the current illness the child has. Depending on the number of visits to the health facility please fill each row appropriately.

€B: Please ask about the costs incurred for registration/consultation and record the amount in the space provided depending on the type of visit. Put zero if no registration/consultation expenses incurred.

©C: Please ask about the costs incurred for Laboratory/ Medical investigation and record the amount in the space provided depending on the type of visit. Put zero if no Laboratory/ Medical investigation expenses incurred.

‡D: Please ask about the costs incurred for prescribed medication and medical supplies and record the amount in the space provided depending on the type of visit. Put zero if no prescribed medication and medical supplies expenses incurred.

#E: If the patient was admitted for in-patient care, please ask about the costs incurred for hospital bed and record the amount in the space provided depending on the type of visit. Put zero if the patient had no hospital bed expenses incurred.

®F: Please ask about Fees paid for medications purchased without prescriptions and record the amount in the space provided depending on the type of visit. Put zero if no Fees paid for medications purchased without prescriptions.

αG: Please ask about any other costs incurred in relation to health facility visit not included in the other categories mentioned (this may include expenses for food, lodging etc) and record the amount in the space provided depending on the type of visit. Put zero if no any other cost incurred. If costs are incurred, please specify why in the space below:

Q0080 Costs incurred for other health care visits

I will ask you if you have made any visits to a traditional healer before coming to health facilities for the current illness the child has and whether you have incurred any costs or not for such visits.			
Q0080	Have you visited a traditional healer before coming to a health facility for the current illness the child has?	1=Yes 2=No	If "Yes", go to Q0081 and then Q0082. If "No" skip both.
Q0081	Why do you choose to go to a traditional healer	1=Treatment is effective 2=There is continuity of care 3=Respectful treatment 4=Proximity 5=Availability of medicine 6=Other, specify	_____
Q0082	Have you incurred any costs because of the visits to the traditional healer for the current illness the child has?	1=Yes 2=No	If "Yes", go to Q0083. If "No" skip Q0083.
Q0083	What is the total amount spent for traditional healers visit? (Please record the amount in the space provided).	Birr _____	

Q0100 Household expenditure

I would like to ask you some questions about how much your household spends on household expenditure including food.		
Household food expenditure		
Q0100	In the last one month, how much did your household spend to buy food?	Birr _____ (-9) Don't know
Q0101	Did you consume food that was grown or produced by the household?	1=Yes 2=No If "Yes", go to Q0102. If "No" skip Q0102.
Q0102	If yes, how much would it cost to buy the quantity of food that was consumed?	Birr _____ (-9) Don't know
Q0103	Did you consume food that was received as wages in kind for work?	1=Yes 2=No If "Yes", go to Q0104. If "No" skip Q0104.
Q0104	If yes, how much would it cost to buy the quantity of food that was consumed?	Birr _____ (-9) Don't know
Q0105	Did you consume food that was received as a gift or loan?	1=Yes 2=No If "Yes", go to Q0106. If "No" skip Q0106.
Q0106	If yes, how much would it cost to buy the quantity of food that was consumed?	Birr _____ (-9) Don't know
Q0107	Did you give away food outside of the household?	1=Yes 2=No If "Yes", go to Q0108. If "No" skip Q0108.
Q0108	If yes, how much would it cost to buy the quantity of food that was given away?	Birr _____ (-9) Don't know
Household non-food expenditure		
About how much money does your household spend per month?		
Q0109	Cooking and lighting Fuel	Birr _____ (-9) Don't know

Q0110	Electricity	Birr_____ (-9) Don't know
Q0111	Health expenses	Birr_____ (-9) Don't know
Q0112	Education	Birr_____ (-9) Don't know
Q0113	Transport	Birr_____ (-9) Don't know
Q0114	Landline phone	Birr_____ (-9) Don't know
Q0115	Mobile phone	Birr_____ (-9) Don't know
Q0116	Liquor & tobacco	Birr_____ (-9) Don't know
Q0117	Household items	Birr_____ (-9) Don't know
Q0118	Personal Effects (Clothes, hygiene)	Birr_____ (-9) Don't know
Q0119	Paid Services (Maid, farm servants, etc)	Birr_____ (-9) Don't know
Q0120	Recreation and entertainment	Birr_____ (-9) Don't know
Q0121	Gifts, charity and Contributions	Birr_____ (-9) Don't know
Q0122	Ceremonies	Birr_____ (-9) Don't know
Q0123	Other (specify_____)	Birr_____

Q0200 Permanent income indicators

I would like to ask you a few questions about your home. Remember that any information you provide will be kept confidential.

Q0200	Can you please tell me how many rooms there are in your home?	_____
Q0201	How many of these rooms are used for sleeping?	_____
Does your household have:		
Q0202	A chair	1=Yes 2=No
Q0203	A table	1=Yes 2=No
Q0204	A bed with cotton/sponge/spring mattress	1=Yes 2=No
Q0205	Electricity?	1=Yes 2=No
Q0206	Kerosene lamp/pressure lamp	1=Yes 2=No

Q0207	A radio?	1=Yes	2=No
Q0208	A refrigerator?	1=Yes	2=No
Q0209	A television?	1=Yes	2=No
Q0210	A VCR/VCD/DVD-player?	1=Yes	2=No
Q0211	A fixed phone?	1=Yes	2=No
Q0212	A generator (electricity/power)	1=Yes	2=No

Does anyone in your household have:

Q0213	A watch?	1=Yes	2=No
Q0214	A bicycle?	1=Yes	2=No
Q0215	A motor cycle?	1=Yes	2=No
Q0216	A car or truck?	1=Yes	2=No
Q0217	An animal drawn cart?	1=Yes	2=No
Q0218	A mobile phone?	1=Yes	2=No
Q0219	Does any member of this household own any agricultural land?	1=Yes	2=No If "Yes", go to Q0220. If "No" skip Q0220.
Q0220	How many hectares of agricultural land do members of this household own?	_____ hectares	
Q0221	Does this household own any livestock, herds, other farm animals, or poultry?	1=Yes	2=No If "Yes", go to Q0222. If "No" skip Q0222.

Q0222	<p>How many of the following animals does your household own?</p> <p>Milk cows, oxen or bulls?</p> <p>Horses, donkeys, or mules?</p> <p>Camels?</p> <p>Goats?</p> <p>Sheep?</p> <p>Chickens?</p> <p>Beehives?</p>	<table border="1" data-bbox="713 305 896 547"> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> </table>																								
Q0223	<p>Does this household own any farm equipments?</p>	<p>1=Yes 2=No</p> <p>If "Yes", go to Q0224. If "No" skip Q0224.</p>																								
Q0224	<p>How many of the following farm equipments does your household currently own?</p> <p>Tractor</p> <p>Machine pulled plow or harrower</p> <p>Animal pulled plow</p> <p>Thresher</p> <p>Machine to process livestock feed</p> <p>Shovels and spades</p> <p>Other (specify _____)</p>	<table border="1" data-bbox="761 724 944 966"> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> </table>																								

