

# Maternal and neonatal health in southern Ethiopia

A cohort study on the incidence of illnesses and utilisation of healthcare services

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Moges Borde Tadesse

Thesis for the degree of Philosophiae Doctor (PhD)  
Hawassa University, Ethiopia and  
University of Bergen, Norway  
2020

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Maternal and neonatal health in southern Ethiopia • Moges Borde Tadesse

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## Dedication

*I dedicate this thesis to my dear late wife, Birtukan Tefera Ayele, who passed away in 2019, and who always encouraged me to attain my goals, and who never failed to support me along the way.*

## Acknowledgements

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My beloved children, Dagmawi and Hilina, thank you for your presence in my life as a light, energy, inspiration, and happiness. Without your understanding, endless love, patience, and support, there could be no thesis. I could also be nothing without you.

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## Abstract

### *Background*

Although mothers and their neonates are inseparably linked in life, their healthcare needs are managed separately. However, healthcare during the pregnancy, delivery, neonatal, and postnatal periods should be looked at together and managed in an integrated way. Therefore, the World Health Organization (WHO) advocates using the notion of ‘continuum of care’ that encompasses the delivery of an integrated range of care for women-neonate pairs in a coherent and timely manner from pregnancy up to when the child is five years old. However, in Ethiopia, there is limited research regarding the delivery of an integrated continuum of care at the community level to improve maternal and neonatal health and healthcare-seeking during illnesses. Moreover, Ethiopia implemented a Health Extension Programme (HEP) to improve access to and quality of healthcare in rural communities. Yet, reducing the burden of maternal and neonatal illnesses and increasing healthcare coverage in these populations remain key challenges. Meanwhile, there are many barriers to low healthcare-seeking, of which financial constraints are important. Specifically, poor households cannot afford to seek healthcare, and they can become trapped in the vicious circle of burdens of poverty and high illnesses (i.e. poverty aggravates the burden of illnesses, and people having a heavy burden of illnesses exacerbates their poverty).

### *Objectives*

This study was done within the context of a continuum of care with the general objective to provide data that could support improvements in maternal and neonatal health and healthcare-seeking. The specific objectives were to assess the incidence and risk factors for illnesses among pregnant women and measure use of healthcare services (Paper I); to assess the incidence and risk factors for illnesses among postpartum women and their neonates, and measure use of

healthcare services (Paper II), and to assess the financial risk of households in seeking maternal and neonatal healthcare (Paper III).

### *Methods*

A prospective cohort study was conducted in three randomly selected *kebeles* in rural southern Ethiopia from May 2017 to July 2018. A total of 896 pregnant women were recruited. Trained data collectors visited every second week and recorded illnesses, the utilisation of healthcare services, out-of-pocket healthcare payments (OOP), total household expenditures, and non-food expenditures from each pregnant woman. Then, a cohort of 784 postpartum women and their 772 neonates were followed up (Paper II). Eight home postpartum follow-up visits were conducted during the first 42 postpartum days and six neonate follow-ups were conducted at the same home over the first 28 days of life. The financial risk (i.e. catastrophic expenditure and impoverishment) of seeking maternal and neonatal healthcare was estimated (Paper III). Annual healthcare expenditure was determined to be catastrophic if out-of-pocket healthcare payments exceeding the threshold of 10% of total household expenditures or 40% of non-food expenditures. Impoverishment due to catastrophic healthcare expenditure was analysed based on total household expenditure and the international poverty line of  $\approx$  \$1.9 per capita per day. The poverty gap was analysed as the ratio by which the mean income of the poor was less than the international poverty line of  $\approx$  \$1.9 per capita per day. Poisson regression model (Paper I), Prentice, Williams, and Peterson's (PWP) total time Cox-type survival model (Papers I and II) and the logistic regression model (Paper III) were used for analysis.

### *Results*

The incidence of at least one type of pregnancy-related illness was 93 per 100 pregnant women-weeks, with an average of eight episodes of illness per pregnant woman. The prevalence of anaemia among pregnant women was 22% and for hypertension 3% (Paper I). The incidence of at least one type of postpartum illness was 31 per 100 postpartum women-days and for neonatal illnesses; it was 48 per 100 neonate-days. Anaemia also occurred in 19% of postpartum women,

and low birth weight (<2,500g) in 15% of neonates (Paper II). However, only 8% of ill pregnant women, 5% of ill postpartum women, and 4% of ill neonates reported utilising healthcare services. Reasons for not utilising healthcare services included a belief that the illnesses were not serious or would resolve on their own, little confidence in the healthcare institutions, and inability to afford the cost (Papers I and II). The risk factors for illnesses were having many previous pregnancies, having a history of stillbirth or abortion (Paper I), and walking more than 60 minutes to access healthcare (Papers I and II). Neonates with birth weight  $\geq 2,500$ g were less likely to experience neonatal illnesses (Paper II). The risk factors for low use of healthcare services were having a history of abortion and walking more than 60 minutes to access healthcare (Paper I). Compared with younger mothers, older mothers with sick neonates or postpartum illnesses were more likely to seek healthcare (Paper II). However, the median total out-of-pocket healthcare payment among households that sought healthcare was \$46 per year, with two episodes of illnesses per household (Paper III). The overall household's budget share of total out-of-pocket healthcare payments was 19% and was highest amongst the poorest households. The poorer households paid more than the richer for healthcare during pregnancy and neonatal illnesses. In contrast, the richer paid more than the poorer during postpartum illnesses. Furthermore, around 46% of households that sought healthcare faced catastrophic healthcare expenditure at the threshold of 10% of total household expenditure, or 74% of households as defined by 40% non-food expenditure. Moreover, around 92% of households that sought healthcare were pushed further into impoverishment due to catastrophic healthcare expenditure.

### *Conclusions*

This thesis shows a high burden of maternal and neonatal illnesses and poor healthcare-seeking in rural communities in southern Ethiopia. Therefore, we recommend strengthening primary healthcare, including illness identification and management, and improving the use of healthcare services, including encouraging women or households to seek and receive appropriate and timely healthcare, which are critical for further reductions in maternal and neonatal mortality.

The maternal and neonatal health programmes should also give priority to and target those at risk of maternal and neonatal illnesses and low use of healthcare services, and to the issue of health inequity when setting priorities to address the lack of fairness in maternal and neonatal health. The efforts of the Ministry of Health should also be directed towards strengthening the health system that enables it to provide a basic integrated continuum of care in identifying, managing, treating, and referring the maternal and neonatal illnesses, using the Health Extension Workers (HEWs). The non-healthcare-seeking behaviour is not only linked to lack of access but also to the women's beliefs about health and illness. Therefore, informing and teaching mothers and women might be the key to improving maternal and neonatal health and healthcare-seeking. Meanwhile, to tackle the trap of a vicious circle of illnesses and poverty, and to achieve the goal of universal healthcare coverage (UHC), poor households who could not afford to seek healthcare should get access to prepayment and financial risk-protection (FRP) mechanisms. Furthermore, we recommend research about the efficiency of the Health Extension Programme in identifying and managing illnesses at the household-community level. The impact of opportunity costs, such as income losses during illnesses, and socioeconomic shocks, or death should also be assessed.

## List of original papers

This thesis is based on the following original research papers, which are referred to in the text by their Roman numerals.

### *Paper I*

Borde MT, Loha E, Johansson KA, Lindtjorn B (2019) Utilisation of health services fails to meet the needs of pregnancy-related illnesses in rural southern Ethiopia: A prospective cohort study. PLoS ONE 14 (12): e0215195. <https://doi.org/10.1371/journal.pone.0215195>

### *Paper II*

Borde MT, Loha E, Lindtjorn B (2020) Incidence of postpartum and neonatal illnesses and utilization of healthcare services in rural communities in southern Ethiopia: A prospective cohort study. PLoS ONE 15(8): e0237852. <https://doi.org/10.1371/journal.pone.0237852>

### *Paper III*

Borde, M.T., Loha, E., Johansson, K.A., Lindtjorn B Financial risk of seeking maternal and neonatal healthcare in southern Ethiopia: A cohort study of rural households. *Int J Equity Health* 19, 69 (2020). <https://doi.org/10.1186/s12939-020-01183-7>

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## Abbreviations/Acronyms

ADePT	Automated development economics and poverty tables
AHR	Adjusted hazard ratio
ANC	Antenatal care
ARR	Adjusted relative risk
CBHI	Community-based health insurance
CHE	Catastrophic healthcare expenditure
CI	Confidence interval
CIH	Centre for International Health
CHR	Crude hazard ratio
CRR	Crude relative risk
EDHS	Ethiopian demographic health survey
ETB	Ethiopian Birr
FRP	Financial risk protection
GDP	Gross domestic product
GTP	Growth and transformation plan
HSDP	Health sector development programme
HDA	Health Development Army
HEP	Health Extension Programme
HEW	Health Extension Worker
IQR	Interquartile range
IRB	Institutional review board
LMICs	Low and middle-income countries
NORHED	Norwegian Programme for Capacity Development in Higher Education and Research for Development
OOP	Out-of-pocket healthcare payments
PWP	Prentice-Williams-Peterson (Cox-proportional survival regression model)

REC	Regional Committees for Medical and Health Research Ethics of western Norway
SDG	Sustainable Development Goal
SENUPH	South Ethiopia Network of Universities in Public Health
SHI	Social health insurance
SPSS	Statistical package for social sciences
STATA	Statistical software package for statistics and data
SRS	Simple random sample
\$	United States dollars
UHC	Universal health coverage
WDGs	Women's Development Groups
WHO	World Health Organization



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## Introduction

### What is this thesis about?

Globally, maternal and neonatal deaths are too high, and low healthcare-seeking among ill mothers and neonates contributes to high death rates [1]. In 2017, every day, approximately 808 women worldwide died from preventable pregnancy-related and postpartum illnesses, of whom sub-Saharan African women alone accounted for 66% (n=533), while Ethiopian women shared 5% (n=40) of the global burden of death [2]. In addition, in 2019, every day, more than 6,700 neonates worldwide died in the first month of life, of which 42% (n=2,814) occurred among sub-Saharan African neonates, while Ethiopia alone accounted for 4% (n=268) [3]. Yet, both maternal and neonatal illnesses have not improved in Ethiopia. For example, in 2016, the United Nations reported that maternal survival has only improved modestly in the world, but not much in Ethiopia in the last decades [4].

Moreover, there is scarce evidence on the incidence of illnesses among women and their neonates, and their subsequent use of healthcare services. Thus, it is critical to obtain more precise estimates from low-resource settings of illnesses during the pregnancy, postpartum, and neonatal periods [5]. This is because studying maternal and neonatal illnesses and use of healthcare services would provide useful first-hand data about mothers' and neonates' exposure to illnesses and healthcare services and also boost the country's scarce data on the topic of this thesis. The potential socioeconomic and demographic factors that are associated with maternal and neonatal illnesses include the cost of healthcare services, geographic location, household wealth status or poverty, mother's marital status, age, education, and occupation [6]. In particular, financial constraints could be one of the causal barriers to low use of healthcare services, as household poverty prevents patients from seeking healthcare [7].

## Continuum of care

As what happens during pregnancy could have consequences for what happens later in life, healthcare during the pregnancy, neonatal, and postnatal periods should be looked at together and managed in an integrated way. However, in Ethiopia, there is limited research evidence about the delivery of integrated care services along a ‘continuum of care’ at the community level to improve maternal and neonatal health and healthcare-seeking during illnesses. Yet, assuring a continuum of care has become a key strategy to improve maternal and neonatal health and healthcare-seeking. A successful continuum of care relies on identifying and addressing where the critical gaps are in seeking healthcare along the continuum and what factors contribute to these gaps at all levels [8]. Furthermore, the continuum of care concept helps to understand how women and neonate pairs are inseparably linked in life, as well as in healthcare needs, and it strengthens the linkages between households and healthcare facilities assuring that the appropriate care is available in each place [9].

Therefore, the World Health Organization advocates using the notion of a continuum of care that encompasses delivery of an integrated range of care for women-children pairs in a coherent and timely manner. This requires access to care at either clinical care settings, or outreach-outpatient settings, or at the household-community level throughout the period from pregnancy up to when the child is five years old [8]. In this thesis, we adopted this concept of a continuum of care; however, the components of a complete continuum of care were not fully assessed. Rather, we centred in identifying problem areas (i.e. identification of maternal and neonatal illnesses, assessing healthcare-seeking and financial constraints). [10]. Our pathway for providing the continuum of care was that we followed up the pregnant women to assess the incidence of illnesses and use of healthcare services in the first phase (Paper I), and then we followed up the postpartum women and their neonates to assess the incidence of illnesses and use of healthcare services in the second and third phases (Paper II). In all three phases, we measured out-of-pocket healthcare payments (Paper III). In all three phases, we assessed three

areas: the incidence of illnesses (measurement 1), use of healthcare services (measurement 2), and out-of-pocket healthcare payments (measurement 3).

### Research environment

The research for this thesis was carried out under the Norwegian Programme for Capacity Development in Higher Education and Research for Development (NORHED) through South Ethiopia Network of Universities in Public Health (SENUPH): Improving women's participation in postgraduate education project. The NORHED-SENUPH project aimed to deliver a joint PhD through the collaboration of the School of Public Health, College of Medicine and Health Sciences, Hawassa University, Hawassa, Ethiopia and the Centre for International Health (CIH), Faculty of Medicine, University of Bergen, Bergen, Norway. This research was funded through the agreement of NORHED-SENUPH project, ETH-13/0025.

### Global maternal and neonatal health

Maternal and neonatal health covers maternal and neonatal health-related conditions that address the health concerns and interventions across the period involving women during and after pregnancy, and neonates, that is, the first 28 days of life [11]. Improving maternal and neonatal health not only helps to secure the right to health but also reduces poverty [11]. Integrated care for maternal and neonatal health is required, as there is an obvious linkage between maternal and neonatal health. Mothers and their infants share several similar and interrelated causes for their illnesses and deaths. Therefore, it is now recognised that providing healthcare on the continuum has multiple benefits, while the disconnection in care affects both mothers and neonates [11].

### The burden of maternal and neonatal illnesses

Maternal conditions encompass events occurring from conception to 42 postpartum days [12]. In addition, the postpartum period is the period from one hour after the delivery of the placenta to 42 days [13], and the neonatal period is the period from birth to 28 days after childbirth [14]. However, the periods during and after pregnancy are not inherently pathological [12]. In spite of

that, a recent World Health Organization systematic review indicates that prevalence figures for illness vary hugely [12], while the burden of maternal illnesses in developing countries remains high [15]. In 2017, approximately 94% of all maternal deaths occurred in developing countries [16], and 50-71% of the deaths happened during the postpartum period [17].

In 2017, 56 million pregnant women experienced spontaneous abortion globally, and 49 million of these were in low- and middle-income countries (LMICs) [18]. Moreover, a small body of emerging literature shows a high incidence of postpartum illnesses in these countries. For example, in 2016, approximately 75% of pregnant women in low- and middle-income countries [19] and 14% in Ethiopia in 2013, reported at least one type of symptom of pregnancy-related illnesses [20]. Furthermore, globally, for every woman who dies of maternal causes, there are at least 20 more women who suffer from illnesses and life-threatening complications during pregnancy or childbirth, and at least 30 more women are left with long-term disabilities [12].

The neonatal period is a period in which the neonate has to adapt to a new environment and is vulnerable to many health problems, a greater risk to survival compared to any other time [21]. Neonates who die within the first 28 days of birth usually suffer from illnesses associated with a lack of quality healthcare at birth, or skilled healthcare and treatment immediately after birth [22]. Worldwide, for every neonate who dies of neonatal causes, there are at least another 20 more neonates who suffer from neonatal illnesses [23]. Most neonatal illnesses occur immediately after birth [24]. In 2018, a study from Bangladesh indicated that among 31% of ill neonates, 37% had more than one symptom, while 67% suffered from fever, 28% from difficult or fast breathing, 28% from low temperature, 13% from poor sucking or feeding, and 10% had chest in-drawing [25]. In 2019, mothers in India reported that 31% of their neonates suffered from jaundice or low birth weight [26].

Despite that, in 2016, the United Nations reported that maternal and neonatal survival has improved in the last decades [4]; however, the published data on the incidence of illnesses among women and their neonates are still weak, and there is scarce evidence on healthcare-



seeking. Thus, it is critical to obtain more precise estimates of illnesses and healthcare-seeking during and after pregnancy [5].

### Factors associated with maternal and neonatal illnesses

Multiple socioeconomic and demographic determinants affect women's and neonates' health negatively. In addition, the cost of healthcare services and poverty play a major role and are associated with maternal and neonatal illnesses [6]. For example, maternal and neonatal illnesses are influenced by economic status, transportation problems, insecurity, marital status, age, education, socio-cultural factors, and healthcare system delivery [27]. Geographic access or remoteness of the woman's home is also linked with and increases the risk for maternal and neonatal illnesses, with negative consequences during and after pregnancy [28]. Some studies indicate that medical factors are also responsible for maternal illnesses such as infection and hypertensive disorder. In addition, age of the neonate, mode of delivery, having had multiple births, the weight of the neonate <2,500gm, place of delivery, and parity were found to be predictors of neonatal illnesses [21]. There are also several contributory physiological or direct factors for maternal and neonatal illnesses [12].

### Utilisation of healthcare services during maternal and neonatal illnesses

Even though the use of healthcare services is a complex behavioural phenomenon during illnesses, appropriate and timely healthcare-seeking are essential for healthy living [29]. However, the rate of use of healthcare services during maternal and neonatal illnesses is low. The severity of maternal illnesses influences the use of healthcare services and appears to be significant (i.e. women who have had a life-threatening condition are more likely to seek healthcare) [29]. Studies on factors associated with the use of healthcare services during pregnancy-related illnesses indicate that healthcare use is related to the availability, quality, and cost of healthcare services, access to healthcare services, health beliefs, and the socioeconomic and demographic environments of the women [30]. The woman's background characteristics

like her educational status, age, occupation, and household socioeconomic status, access, and travel time to a healthcare facility also influence healthcare-seeking [29].

During neonatal illnesses, in addition, healthcare-seeking is closely linked with several interrelated delays that prevent the neonate from receiving available healthcare services [31]. For example, a review of observational studies at a community level in low- and middle-income countries indicated that the pathways for use of healthcare during neonatal illnesses are influenced by many factors and contributed to delays in healthcare-seeking [31]. These include predisposing factors (i.e. a sense of the illness being God's will or fate, past experiences, perceived benefits and barriers, timely recognition of symptoms, lack of awareness, and personal choices); socioeconomic constraints (i.e. availability of finances); health service factors (i.e. affordability, accessibility, availability, and acceptability of the healthcare services); and lack of security or unrest [31]. In Ethiopia, the causes and burdens of maternal and neonatal illnesses and use of available healthcare services have not yet been well described. However, improving maternal and neonatal health and healthcare-seeking are also key challenges [32].

### Financial barriers during maternal and neonatal illnesses

The household economy and maternal and neonatal illnesses are closely related and facilitate a lock between poverty and ill-health [33]. Households with a higher burden of poverty tend towards less healthcare expenditure during illness. This is because the vicious cycle of the burdens of poverty and high illness often leads to a situation where poverty aggravates the burden of illnesses, and heavy burdens of illnesses exacerbate poverty [34]. However, if affordable healthcare had been available, falling into chronic poverty could have been prevented [7]. Moreover, financial risks during illnesses might force households to cut their necessities and sell assets [35]. Poor households may not even be able to afford to seek essential healthcare, remaining trapped in the vicious circle of illness and poverty [35, 36]. As a result, due to high catastrophic healthcare expenditure, women and their neonates would likely forgo the healthcare that they need, as they could not afford it. Possible influencing factors are household economic

status, educational status, and occupation of the head of the household [37]. For example, even though the primary objectives of universal health coverage are to treat sick people and protect them from financial risk [38], and health insurance is a major mechanism that pools financial risk and assures more predictable healthcare finances [39], households in low- and middle-income countries (LMICs) with tight financial constraints still pay high out-of-pocket healthcare payments at the point of healthcare-seeking [40].

Moreover, there is low coverage or use of healthcare services during illnesses, and financial barriers could be one of the causal barriers to accessing healthcare [41]. Household poverty prevents patients from seeking healthcare. Furthermore, poor households remain poor because they cannot cope with the negative consequences of financial risks during illnesses, and they could be further pushed down into extreme poverty [7]. In general, the contrasts like these between the high burden of illnesses and healthcare payments that exceed the income of the poorer households are very common in developing countries [7].

## Maternal and neonatal health in Ethiopia

### Ethiopia: The country

Ethiopia, officially the Federal Democratic Republic of Ethiopia, is a country located in the horn of Africa. Ethiopia is a landlocked country with over 109 million inhabitants as of 2019 [42]. Ethiopia is one of the most populous countries in the world, as well as the second-most populous nation in the African continent. The country occupies a total area of 1.1 million square kilometres, and its capital city is Addis Ababa [43]. Of the current population, 51% are women, and 46% fall between 1 and 14 years, 51% between 15 and 64 years, and 3% are over 65 years old. Approximately 17% of the population is estimated to live in urban areas. The overall life expectancy of the population is currently 65 years [43]. In Ethiopia, more than 80 languages and over 200 dialects are found. Amharic is the official language, although the government encourages local languages to be taught in schools. Afan-Oromo and English languages are also

widely spoken [43]. The Ethiopian economy is dominated by agriculture and service sectors. Agriculture accounted for 46% of gross domestic product (GDP), 84% of exports, and 80% of the labour force in 2006/2007, and agriculture remains the Ethiopian economy's most important sector. Exports are highly concentrated, with coffee alone accounting for more than 60% of the total. The currency in Ethiopia is called the Ethiopian Birr (ETB) [43]. However, Ethiopians are suffering from the lack of the basic needs of life, such as food, healthcare, housing, education, and a safe and healthy environment [43].

### Maternal and neonatal illnesses in Ethiopia

As a country, in 2017, Ethiopia experienced approximately 14,000 maternal deaths, which is 5% of global maternal deaths [44]. In addition, in 2019, approximately 99,000 neonatal deaths were reported in Ethiopia [3]. In 2017, the rate of spontaneous abortion was 28 per 1000 women [45]. In 2015, the global number of stillbirths was estimated to be 2.6 million [45], but Ethiopia accounted for 4% of these (97,000 stillbirths) [45]. In 2017, approximately 42% of pregnant women in developing countries were estimated to suffer from anaemia [46], while 25% of Ethiopian pregnant women had anaemia [47]. Although iron-folic-acid supplementation is recommended for the prevention or treatment of anaemia in all pregnant women before and after delivery [48], limited data from Ethiopia exist concerning the uptake of iron-folic-acid supplementation during the antenatal and postpartum periods [47]. Hypertension is also common during pregnancy and occurs among 10% of pregnant women globally [49], and 6% in Ethiopia [50].

Since 2003, despite the implementation of a Health Extension Programme to improve access to and quality of healthcare in rural Ethiopian communities [51], approximately 70% of pregnant women still deliver at home, and healthcare-seeking for ill neonates has remained low. In 2016, among women with postpartum illnesses, about 70% had no access to healthcare as they lacked money [44]. Further, only 17% of women received healthcare after childbirth in 2016 [44]. In sub-Saharan Africa, one in every 12 neonates [52], but one in every 15 Ethiopian neonates, dies

before the fifth birthday [44]. Ethiopia is one of the developing countries that have a high burden of neonatal illnesses [52]. In 2009, in Ethiopia, illnesses were reported among 26% of neonates [53], and the 2016 Ethiopian Demographic and Health Survey (EDHS) reported that 13% of children had low birth weight [44].

### Financial barriers during maternal and neonatal illnesses in Ethiopia

Maternal and neonatal illnesses are one of the underlying causes of a poverty trap in Ethiopia which may be due to high out-of-pocket healthcare payments that result in severe financial risks for poor households [54]. For example, in Ethiopia, 31-34% of the national healthcare budget (total healthcare expenditure) was financed by out-of-pocket healthcare payments (2010/11-2016/17) [36, 55, 56], which put households in a poverty trap and is considerably higher than the 21% global average, the 15-20% global target, and even higher than 30% average for low- and middle-income countries [56, 57]. In 2013, in Ethiopia, it was estimated that 350,000 poverty cases were due to direct out-of-pocket medical costs [58]. Furthermore, approximately 7% of Ethiopian households had a child who suffered from severe pneumonia, and approximately 6% of Ethiopian households were pushed into extreme poverty by severe diarrhoea.

Poorer and rural households were more likely to be impoverished and remain in the vicious cycle of poverty and illnesses due to out-of-pocket healthcare payments [59]. This means out-of-pocket healthcare payments are highly linked to financial risks which led households into a poverty trap [55]. Furthermore, neonatal illnesses usually need specialised healthcare and result in huge out-of-pocket healthcare payments, putting the family in a poverty trap. This is explained by the statistic that 27% of the Ethiopian population are living on less than \$1.9 per capita per day, and many of these people cannot afford healthcare services [60]. Consequently, the Ethiopian government is attempting to remove financial barriers to healthcare-seeking, to reduce catastrophic healthcare expenditure, and to increase the use of healthcare services by

scaling-up health insurance schemes such as Community-Based Health Insurance (CBHI) for informal sectors of the economy in both urban and rural areas.

### Health services in Ethiopia

Ethiopian health policy reforms have given priority to maternal and neonatal health and scaling-up services and providing a continuum of care [61]. The Ethiopian health sector development programme (HSDP) (2015-2020) sets out a strategy to improve the accessibility of health services to ensure utilisation; it presents key steps to improve the health of mothers and neonates with emphasis on increasing coverage, quality, and equity [61]. Therefore, in Ethiopia, the health service is restructured into a three-tier system (i.e. primary, secondary, and tertiary levels of healthcare), and the healthcare system is organised based on the type of healthcare provided [11]. The primary tier system is the first level and comprises one primary healthcare unit which is one health centre with five satellite health posts and one primary hospital. One health centre is designed for 15,000-25,000 people in rural areas, and 40,000 people in urban areas, and each health post is for 3,000-5,000 people in rural areas. The primary hospital serves 60,000-100,000 people. The secondary tier system includes a general hospital which is for 1-1.5 million people, and the tertiary tier system includes a specialised hospital that is for 3.5-5 million people. The chain of referral linkage in the three-tier health system is that the health post refers to the health centre, the health centre refers to the primary hospital in the primary healthcare unit, and then to the secondary level of healthcare (i.e. the general hospital), and then to the tertiary level of healthcare (i.e. the specialised hospital) [11].

Community-based maternal and neonatal care aims to identify and treat illnesses through the primary tier system at health post level using Health Extension Workers; these are lay individuals who are not nurses or trained healthcare professionals, although they have received one-year training on primary healthcare. Thus, mothers of neonates have to believe and develop confidence that they will be able to receive the best healthcare when they are in need, that they are at low risk of contracting illnesses, ultimately leading to better health status [61]. The health

extension system is combined with the local Women's Development Groups (WDGs) and networks of the Health Development Army (HDA) in their communities (*kebeles*) to improve maternal and neonatal health. This is because the primary tier system embraces the entire healthcare services provided at all levels, focusing on communicable diseases, maternal health, common nutritional disorders, hygiene, and environmental health.

Maternal and child healthcare, immunisation against childhood illnesses, family planning and reproductive health, and infectious diseases, including tuberculosis, malaria, and control of sexually transmitted infections and HIV/AIDS, are also areas that Health Extension Workers deal with. Ill women and neonates primarily use Health Extension Workers at health posts. If the case is serious, the Health Extension Worker may refer them to a health centre [11]. According to the national antenatal care (ANC) guidelines in Ethiopia, focused antenatal care is advised to take place at least four times during a pregnancy. The main components of antenatal care include blood pressure measurement, nutritional counselling, iron-folate supplementation, and information about the danger signs of pregnancy complications, as well as protection at birth from tetanus [44]. In 2016, the proportion of pregnant women attending at least one antenatal care session in Ethiopia was 62% [44].

### Existing strategies to improve maternal and neonatal health

The health targets in Sustainable Development Goal (SDG) number-3 constitute one of the major agenda items of universal health coverage (UHC) to ensure healthy lives and promote the well-being of women and their neonates by 2030, so that, the public health-related components of the healthcare system are strengthened [62]. Sustainable Development Goal number-3 is one of the main goals guiding strategies for both countries and global institutions, and for providing a comprehensive framework to improve maternal and neonatal health and to promote an integrated approach to the implementation of interventions from preconception through the postpartum period [62]. In addition, SDG-3 aims to reduce the maternal mortality ratio to less than 70 per 100,000 live births, to end preventable deaths of neonates, and to reduce neonatal

mortality to at least as low as 12 per 1,000 live births. Other goals include the integration of reproductive health into national strategies and programmes, universal healthcare coverage in focused areas (i.e. financial risk protection, quality of essential healthcare services, and safe, effective, good quality and affordable essential medicines, healthcare financing and the recruitment, development, training, and retention of the health workforce).

Neonates also require additional attention and care during hospitalisation and at home to minimise their health risks [22]. Therefore, accelerated progress for neonatal survival and the promotion of health and well-being were designed to strengthen and ensure the availability of quality healthcare services during neonatal illnesses [22]. Moreover, the World Health Organization's responses, along with ministries of health and partners, were used as strategies to improve neonatal health [22], in terms of strengthening and investing in healthcare around the time of birth and the first week of life; improving the quality of neonatal healthcare from pregnancy to the neonatal period; and expanding quality healthcare services for ill neonates.

Since September 2015, after the adoption of the agenda for Sustainable Development Goals by 2030, Ethiopia has mainstreamed and aligned the Sustainable Development Goals with the national Second Growth and Transformation Plan (GTP II), which spans from 2015/16 to 2019/20 [63]. Furthermore, the government of Ethiopia is also formulating a ten-year second phase of the development plan that spans from 2019/20 to 2029/30 [63]. The national Growth and Transformation Plan-II, on maternal and neonatal health in Ethiopia, emphasises strengthening public health-related components of the healthcare system that are important to achieving the Sustainable Development Goals [62].

Universal health coverage is also advocated as a crucial approach so that every citizen can receive high-quality health services they need, without financial risk [64]. Based on this universal health coverage agenda, many efforts in Ethiopia have been undertaken to introduce health insurance and safety-net programmes. The Ethiopian government has



introduced some of the schemes to support poor patients, to remove financial barriers associated with healthcare-seeking, reduce catastrophic healthcare expenditures, and increase the use of healthcare services by scaling-up health insurance schemes in several major ways. These include Community-Based Health Insurance for informal sectors of the economy in urban and rural areas, which now covers over 22.5 million citizens [65], and Social Health Insurance (SHI) for civil servants and the formal sector, which is going to be launched by the government [55]. However, poor mothers and neonates, with a high rate of illnesses, are still making a considerable amount of out-of-pocket healthcare payments [36] because Community-Based Health Insurance schemes were not yet in place in the study area when data were collected.

### Context of the study

This thesis was conducted in Gedeo, which is a zone (i.e. one of the second-level administrative divisions in Ethiopia) and located in the Southern Nations, Nationalities, and Peoples' Region (SNNPR) of Ethiopia (i.e. region is the first-level administrative divisions in Ethiopia). This zone is named for the Gedeo ethnic group people, whose homelands lie in the zone, and they speak the Gedeo language. Gedeo zone is located 420 km away from Addis Ababa along with the Ethiopia-Kenya international road, with Dilla town as the administrative centre of the zone. Agriculture is the base of the economy of the zone and is the dominant means of livelihood. Agriculture employs an estimated 89% of the population. Gedeo zone is one of the major coffee-producing zones of the region and well known for producing high-quality Yirgacheffe organic coffee for the international market. Gedeo zone is one of the most densely populated areas in the country, with an estimated population density of 980 persons per km<sup>2</sup>. Furthermore, the rapid growth of the population has resulted in fragmentation and reduction of farm sizes, adversely affecting the production and productivity of food crops [66].

The study area of this research was Wonago district, which is one of the six districts of Gedeo zone. A district (i.e. known in Amharic named as a *wereda*) is also one of the third-level administrative divisions of Ethiopia. Districts are again further subdivided into several

*kebeles*; a *kebele* is the lowest administrative unit of local government in Ethiopia and comprises approximately 1,000-1,500 households (an average of 5,000-7,500 people [67]). Wonago district is similar in socio-demographic and economic features to most rural areas in Ethiopia. As described above, in the Ethiopian three-tier healthcare system, health centres and health posts are the first levels of primary healthcare units in the system that provides all the levels of healthcare to the community. The chain of referral linkage is that the health post refers to the health centre, the health centre refers to the primary hospital in the primary healthcare unit, and then to the secondary level of healthcare, and then to the tertiary level of healthcare [11]. However, one of the challenges while conducting this research was that there was social unrest or displacement in the study area during the study period. Ethnic conflict in the Gedeo Zone since 2018 led to Ethiopia having the largest number of displaced people globally flee their homes in 2018 [68].

## Rationale for this thesis

There is an improvement in maternal and neonatal death due to favourable international and national policies [9]. However, even though the ‘continuum of care’ concept is useful to avoid dichotomies in healthcare delivery between mothers and neonates, there is a lack of an integrated provision of a continuum of care services in Ethiopia [8], as well as a lack of integration between maternal and neonatal health programmes [69]. Furthermore, even though universal health coverage is advocated as a crucial approach so that every citizen can receive the high-quality health services they need, without financial risk, the overall effective coverage performance in Ethiopia was only 47%. Moreover, the corresponding individual effective coverage performance was very low (i.e. 16% for neonatal care, and 16% for maternal care) [64].

Moreover, despite the implementation of the Health Extension Program in rural communities of Ethiopia, improving access to, enhancing the quality of care, improving maternal and neonatal health, and healthcare-seeking are still demanding action and remain key challenges of the

programme [70]. This is because delayed healthcare, or not seeking healthcare at all, may aggravate the illness or may lead to death, unless effective treatment is received. However, there are many barriers to healthcare-seeking, of which financial constraints are important. Specifically, poor households are unable even to afford to seek healthcare and they remain trapped in a vicious circle of illnesses and poverty. The vicious cycle of burdens of poverty and high illness often means that poverty aggravates the burden of illnesses, and a heavy burden of illnesses exacerbates poverty [71].

Surprisingly, few households are utilising healthcare services, and catastrophic health expenses could bring large numbers of households into an increasingly severe impoverishment or push them into chronic poverty. The poverty gap among rural households is also high in terms of paying to obtain healthcare. Therefore, remedies for this need to be implemented on a larger scale and this requires knowledge generation to improve maternal and neonatal health and healthcare-seeking [70]. Besides, inequity in the household budget's share of total out-of-pocket healthcare payments is still demanding action [7]. Such community-level knowledge is important to account for ground-level facts. Even though one of the key priority areas of universal health coverage is to improve maternal and neonatal health and healthcare-seeking, there are still growing inequalities in the use of healthcare services [72]. The disparities are because of differences between rural communities, in terms of poverty and perhaps utilisation of healthcare services during maternal and neonatal illnesses [72].

Furthermore, a major gap in improving maternal and neonatal health and healthcare-seeking lies in the lack of research evidence at the community level, the ability to convert those data to usable information, and the initiation of policy actions [73]. Therefore, this gap demands further effort as well as research to help guide policy formulation and implementation. In Ethiopia, it is now a matter of urgency to define and adopt evidence-based approaches to supplement the existing maternal and neonatal healthcare programmes [73]. Therefore, this research study was done within the context of the required continuum of care and aimed to fill these gaps by

assessing and providing evidence on the incidence of illnesses and healthcare-seeking and by measuring the financial constraints to seeking healthcare.

The research questions were:

- What is the burden of the incidence of illnesses among women and neonates?
- What is the rate of use of healthcare services?
- What is the burden of out-of-pocket healthcare payments along the continuum of care for antenatal, postnatal, and neonatal illnesses?

In addition, the rationale for conducting this study is that it is one of the first attempts in Ethiopia to use a cohort design in defining the health problems and financial constraints in the community. Earlier studies used cross-sectional designs and they also evaluated the same problems by looking from the institutional point of view. This thesis provides a platform to share experiences and discuss maternal and neonatal health, to find solutions to how these illnesses can be reduced or prevented, to indicate how to improve the low use of healthcare services, and how high out-of-pocket healthcare payments can be prevented or reduced in the future at a national level. Accordingly, our research aimed to fill the gap so that every woman and neonate can receive timely and appropriate healthcare services [74].

Therefore, this thesis has some policy implications, in that it helps policymakers to identify gaps where policy can be developed and implemented. The findings indicate that the risk factors and burdens of illnesses and the use of available healthcare services could be important information for intervention, policy formulation, and at large to improve maternal and neonatal health and healthcare-seeking. It is also useful for local-level planning by healthcare managers (Papers I and II). Furthermore, out-of-pocket healthcare payments could be one of the causal barriers for the poor healthcare-seeking among poor households (Paper III), and data on this can also contribute to the formulation of strategies. It could also be a supplementary option to improve maternal and neonatal health, while also providing information for the growing body of

scientific knowledge. The healthcare system may also take local initiatives based on these findings.

## Conceptual framework

A conceptual framework is defined as a logical orientation and associations of underlying thought and plans, which guide the implementation of a research project [75]. We developed and applied a conceptual framework that captures elements of our general objective to provide data that could support improvements in maternal and neonatal health and healthcare-seeking. We also used the model of the continuum of care that is critical to improving maternal and neonatal health and healthcare-seeking and to understand how mothers and neonates are linked in life and healthcare needs. Therefore, even though our conceptual framework was based on the World Health Organization's complete continuum of care building blocks for women-child pairs [8], our research centred on identifying problem areas or outcome variables from pregnancy through to the postpartum period (i.e. identification of maternal and neonatal illnesses, measuring healthcare-seeking and financial constraints). The resulting conceptual framework outlines the interconnected healthcare services required at different phases, maternal and neonatal outcomes, and contributing socio-demographic factors that influence the outcomes (see Figure 1).

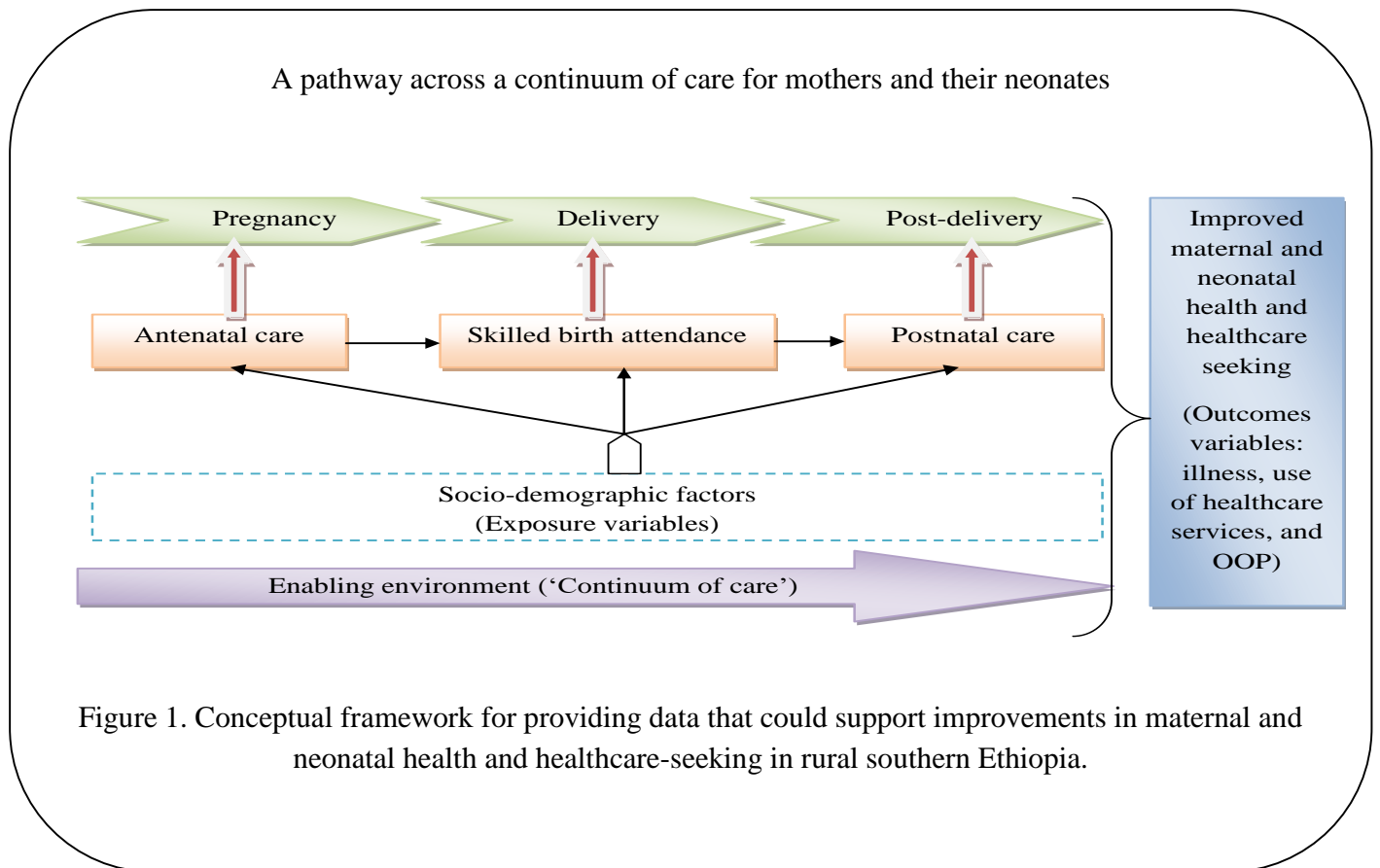


Figure 1. Conceptual framework for providing data that could support improvements in maternal and neonatal health and healthcare-seeking in rural southern Ethiopia.

## Objectives

### General objective

The general objective of this thesis was to provide data that could support improvements in maternal and neonatal health and healthcare-seeking in rural southern Ethiopia.

### Specific objectives

1. To assess the incidence of and risk factors for pregnancy-related illnesses among pregnant women and to measure utilisation of healthcare services (Paper I).
2. To assess the incidence and risk factors for illnesses among postpartum women and neonates and to measure utilisation of healthcare services (Paper II).
3. To assess the financial risk of seeking maternal and neonatal healthcare (Paper III).

## Methods

### Study area and period

The research for this thesis was conducted in Wonago district which is located in the Gedeo zone in southern Ethiopia from May 2017 to July 2018. Wonago district is located 420 km far away from the capital, Addis Ababa, and has 15 rural and four urban *kebeles*. In 2017, the total population of Wonago district was estimated to be 145,000 people [66]. Wonago district has six health centres, 20 health posts, and two private clinics. Three rural *kebeles* were randomly selected by the lottery method (i.e. Hase-Haro, Mokonisa, and Tumata-Chiricha). These three rural *kebeles* were similar in socio-demographic and economic features to most rural areas in Ethiopia. In 2013, more than 80% of the population lived in rural Ethiopia, 26% of the rural residents lived on less than \$1 per day, and 77% of rural women needed to travel more than 20 km to get to a hospital [76]. Mokonisa *kebele* has one health centre and two health posts,

Tumata-Chiricha *kebele* has one health post, and Hase-Haro *kebele* has one health centre and one health post. In 2017, the estimated total population of these three *kebeles* was 29,780 people [66], and the crude birth rate of rural people in Ethiopia was 33.2 per 1,000 population [44].

### Study design

A prospective cohort study design was employed for all three papers to measure the incidence of illnesses, utilisation of healthcare services, and out-of-pocket healthcare payments. A cohort of 896 pregnant women who were attending antenatal care at health posts and who were without illnesses was recruited when we first interviewed them. Then, the exposures were measured before the onset of illnesses (i.e. socio-demographic characteristics of the women and households). We followed up these pregnant women every second week, recording illnesses that occurred (Paper I). The results from Paper I were used as a baseline for the subsequent cohort studies (Papers II and III). Then, a cohort of 784 postpartum women and their 772 neonates were followed up. Eight home postpartum follow-up visits were conducted during the first 42 postpartum days and six neonate follow-ups were conducted at the same home over the first 28 days of life (Paper II). As exposure change over time, these were assessed at the first meeting with the women and then reassessed during illness follow-up.

### Sample size

The sample size was determined by Openepi software Version 3.03 ([www.openepi.com](http://www.openepi.com)) for epidemiological studies (Paper I) [77]. This sample size was also used for the postpartum and neonatal study (Paper II) and the economic evaluation (Paper III). We assumed a 15.5% incidence of pregnancy-related illnesses, and a 1.65 relative risk [20] among poor women, compared with rich women (95% CI; 80% power; 1:1 ratio of unexposed to exposed). After adding 10% for non-response, the required sample size was estimated to be 896 pregnant women (i.e. 91%; 896 of 989 expected pregnant women) (Paper I). During the follow-up, 11% (102 of 896) of pregnant women had incomplete data and were excluded (i.e. 86 women dropped out, one died, one refused to participate, and 14 abortions occurred after week 21 and



before 28 weeks of gestation). Thus, in Paper I, the response rate was 89% (i.e. 794 of 896 sampled pregnant women) (or 80% of 989), who were included in the final analysis. In Paper II, the response rate was 99% (784 of 794 postpartum women) and (772 of 782 neonates) as ten women and ten neonates had incomplete data. Therefore, 794 pregnant women (Paper I), 784 postpartum women and their 772 neonates (Paper II), and 794 households as a whole (Paper III) were included in the analysis (see Table 1).

Table 1: Overview of the objectives, study design, and methods

Paper	Objective	Study design	Methods
Paper I Utilisation of healthcare services fails to meet the needs of pregnancy-related illnesses	To assess the incidence and risk factors for pregnancy-related illnesses among pregnant women and to measure their use of healthcare services	A prospective cohort study of 794 pregnant women	<ul style="list-style-type: none"> <li>• Each pregnant woman was visited every two weeks at home</li> </ul>
Paper II Incidence of postpartum and neonatal illnesses and utilisation of healthcare services	To assess the incidence of and risk factors for illnesses among postpartum women and neonates and to measure their use of healthcare services	A prospective cohort study of 784 postpartum women and their 772 neonates	<ul style="list-style-type: none"> <li>• Eight home postpartum follow-up visits during the first 42 postpartum days</li> <li>• Six neonate follow-ups at the same home over the first 28 days of life</li> </ul>
Paper III Financial risks of seeking maternal and neonatal healthcare	To assess the financial risk of seeking maternal and neonatal healthcare	A prospective cohort study of 794 households (i.e. including 794 pregnant women, 784 postpartum women, and their 772 neonates)	<ul style="list-style-type: none"> <li>• To measure the financial risks, three variables were used (i.e. out-of-pocket healthcare payments, total household expenditure, and non-food expenditure)</li> </ul>

## Participants

A two-stage cluster sampling design was used, and the target population was divided into clusters (*kebeles*) within the district. First, three *kebeles* were selected at random and then the data were collected from all units as a census within each *kebele* (i.e. pregnant women who were attending two or more antenatal care visits at health posts). The recruitment of pregnant women started in May 2017 and follow-up ended in July 2018. Trained data collectors visited each participant at regular intervals at home (i.e. fortnightly visits for pregnant women, eight home follow-up visits during the first 42 postpartum days, and six neonate follow-ups at the same home over the first 28 days of life).

Socioeconomic and demographic characteristics of every pregnant woman were collected and used as a baseline for the whole cohort study. Included participants were those who participated in the respective pregnancy-related, postpartum, and neonatal illnesses studies, and who were identified during scheduled visits. Unfortunately, we did not include women with fewer than two antenatal care visits. However, the proportion of observed antenatal visits was 80.3% and ranges from 70.6% to 85.2% among the three *kebeles* (i.e. number of pregnant women included in our study of the expected total number of pregnant women). There was no significant difference between the expected and actual births from the three *kebeles* ( $P$ -value  $<0.09$ ). The following study participants were also excluded: those who were not easily contacted or those who presented with illness after arranged visit days, as they may have introduced bias due to inclusion of illness beyond the defined time frame for pregnancy, postpartum, and neonatal periods.

## Measurements

Even though information on maternal and neonatal illness and healthcare-seeking is frequently collected at the health facility level using medical diagnosis, it is the only representation of patients who sought care. Therefore, community-based studies in low- and middle-income countries rely on self-reporting, and it has been demonstrated to be effective. In capturing data relating to illnesses and use of healthcare services, this was described as presence (yes) or absence (no) of symptoms or events. Household expenditure and out-of-pocket healthcare payments were described as the amount of expenditure or payments. [78]. Therefore, we used self-reports of symptoms and events using regular periodic face-to-face interviews; in addition, some measurements were done to assess women's and neonates' health status. During the interview, the questions were read aloud and the women selected among responses. All the data on socio-demographic variables, outcome variables and total household expenditure were assessed in the same way, using the same questions, and data collection methods.

Blood pressure (BP) was measured among pregnant and postpartum women by the Riester ri-champion<sup>®</sup>N digital apparatus ([www.riester.de](http://www.riester.de)), and high blood pressure was defined by a measurement of  $>140/90$  mmHg [79]. Hypertension during pregnancy was classified as either a systolic blood pressure  $>140$  mmHg, or diastolic blood pressure  $>90$  mmHg, or both. At the time of each visit, blood pressure readings were taken with at least a one-minute interval [80] between two consecutive readings, and their mean was recorded. Haemoglobin (Hgb) was measured by the HemoCue analyzer @Hb 301 System ([www.hemocue.com](http://www.hemocue.com)). Hgb values for pregnant women (Paper I) were categorised into no anaemia ( $\geq 11$  g/dl), mild anaemia (10-10.9 g/dl), moderate anaemia (7-9.9 g/dl), severe anaemia (4-6.9 g/dl), and very severe anaemia ( $\leq 3.9$  g/dl). As the concentration of Hgb declines during the first trimester, reaches its lowest point in the second trimester and begins to rise again in the third trimester, due to physiological changes, Hgb values for pregnant women were determined at around the third trimester, or 27 gestational weeks or later [81].

In Paper II, the women and neonates with illnesses were identified based on symptoms and clinical measurements such as haemoglobin levels and blood pressure for postpartum women and the weight of the neonates at birth [5]. Measurements of haemoglobin, blood pressure, and weight of the neonates at birth were recorded by trained data collectors. We defined anaemia among postpartum women as a haemoglobin value of  $<12$  g/dl, with testing done six weeks after childbirth [81]. Low birth weight was defined as  $<2,500$ g. Low birth weight is a result of preterm birth (i.e. gestation  $<37$  completed weeks), intrauterine growth restriction (i.e. foetal growth restriction), or both, and is measured in the first 48 hours of life [82]. Neonatal mortality was defined as the death of the neonate within the first 28 days of life. Neonates' weight and length were measured using the Health O Meter<sup>®</sup> Portable Home Care Baby Scale (Pelstar, LLC; [www.chichestershomecare.net](http://www.chichestershomecare.net)).

In Paper III, three variables were used to measure the financial risks: out-of-pocket healthcare payment, total household expenditure, and non-food expenditure. The relationship between socio-demographic characteristics of women or households (i.e. primary exposure variables) and

incidence of illnesses (i.e. primary outcomes variable), use of healthcare services, and out-of-pocket healthcare payments were measured.

We defined healthcare services according to the *Encyclopaedia of Behavioural Medicine* as ‘an array of medical care or services that are recognised under state law and are performed by healthcare professionals or under their direction, for promotion, maintaining, or restoring health to those in need, for example for patients, families, and communities in either of all settings of healthcare (i.e. health posts, health centres, hospitals, and homes or community level) [83]. The number of times healthcare services were used was determined as any use by the women and their neonates or any visit to a healthcare facility to treat pregnancy-related or postpartum or neonatal illnesses [83]. We adapted a working definition of maternal illness by the World Health Organization: i.e. maternal illness is any health condition in a woman attributed to and/or aggravated by pregnancy and childbirth or its management, that has a negative impact on the woman’s well-being during the pregnancy, delivery, or postpartum period, but which is not from accidental or incidental causes [19]. We defined neonatal illness as a disturbance of the normal state of the body, organs and abnormal function of a neonate [84].

### Assessment of exposure and outcome variables

The exposure variables were the socio-demographic characteristics of women. Women’s basic characteristics were defined as their age, age at first marriage and first birth, household size, marital status, educational status, occupation, wealth index, total monthly household expenditure, gravidity, parity, birth interval, history of abortion, and stillbirth. Community- or *kebele*-level exposures of the women were the type of road to the nearest health facility and the walking distance/time to the nearest health facility. The illness was used as an exposure variable for healthcare services and out-of-pocket healthcare expenditure. The weight of the neonate at birth was used as an exposure variable for neonatal illnesses, the use of healthcare services, and out-of-pocket healthcare expenditure (see Table 3).

Table 2: Definition of exposure variables

Variable	Definition	Paper
Woman's age	The number of years that the woman was alive at the time of the interview date.	Papers I, II, III
Women's age at first marriage	The age (in years) when a woman began living with her first husband or consensual partner.	Papers I, II, III
Women's age at first birth	The age of women (in years) at the birth of the first child.	Papers I, II, III
Household size	The number of persons living together in one house who make common provision of food, shelter, and other essential living.	Paper III
Marital status	Woman's situation of being married or not married.	Papers I, II, III
Educational status	Assessed according to highest education level attained by the woman or mother of a neonate (categorised as 'had formal education' vs. 'had no formal education')	Papers I, II, III
Occupation	A woman's usual or principal work or business, especially as a means of earning a living (categorised into 'other [daily labourer, farming, etc.]' vs. 'domestic service')	Papers I, II, III
Wealth index	The wealth index was constructed using principal component analysis from household assets-related variables. The households were then ranked into two categories ('poor' and 'rich').	Papers I, II
	The wealth index was constructed using total household expenditure from household expenditure-related variables. Then, households were ranked into five categories ('lowest', 'second', 'medium', 'fourth', and 'highest').	Paper III
Total monthly household expenditure	The total amount of expenditure made by residents of the household.	Papers I, II, III
Gravidity	Total number of pregnancies in a lifetime (includes complete or incomplete) (categorised into 'multigravida' vs. 'primigravida')	Papers I, II, III
Parity	Number of children previously borne by a woman (excludes abortions, but includes stillbirths) (categorised into 'multipara' vs. 'nullipara')	Papers I, II, III
Birth interval	The period between the two most recent consecutive births (categorised as 2+ years vs. <2 years)	Papers I, II, III
Abortion history	A woman with a history of pregnancy that was ended before 28 weeks of gestation (categorised as yes vs. no)	Papers I, II, III
Stillbirth history	A woman with a history of a baby that was born with no signs of life at or after 28 weeks' gestation (categorised as 'yes' vs. 'no').	Papers I, II, III
Type of road to the nearest health facility	The type of road that was used to reach the nearest health facility that households visited frequently in this study (categorised as 'asphalt' vs. 'other').	Papers I, II, III
Walking distance to the nearest health facility	The distance and the time it took to reach the nearest health facility that households visited frequently in this study in minutes (i.e. health post, health centre, hospital).	Papers I, II, III
Illness	The condition of being ill, or in poor health; sickness; or disease that a woman or a mother of a neonate reported as having any illness.	Papers I, II, III
Weight of the neonates at birth	The first weight, measured within hours of birth; however, in community-level settings, within the first 48 hours of life.	Paper II

The criteria for identifying illness among pregnant women, postpartum women, and neonates were decided before initiating the study. The concepts of illness have been used to indicate personal ailments (i.e. subjective undesirable states of health) [85]. Illness identification criteria were based on general symptoms. We assumed that women and neonates would seek healthcare primarily due to medical problems.

The primary outcome variable was the incidence of illnesses. The maternal illnesses were determined using the 'World Health Organization maternal morbidity measurement tool pilot study protocol' [86], and neonatal illnesses were determined using the Johns Hopkins University

Tools and Indicators for Maternal and Newborn Health [87]. A community-based approach was used to assess the need for the use of healthcare services during illness [88]. Out-of-pocket healthcare payment was measured based on an earlier survey in Ethiopia [89], and the data collection was guided by published techniques and their implementation to analyse health equity using household survey data [90] (see Table 2). Even though we did not collect data on informal ‘envelope’ payments for healthcare services, there are several problems in Ethiopia, including informal healthcare provision, illicit charging, and corruption [91]. Besides, the details of the operational definition of illnesses in this thesis are presented in Tables 5a, 5b, and 5c.

Table 3: Definition of outcome variables

Variable	Definition	Paper
Pregnancy-related illnesses	A pregnant woman who reported as having any pregnancy-related illnesses during the pregnancy period	Paper I
Postpartum illnesses	A woman after childbirth who reported as having any postpartum illnesses within 42 days after childbirth	Paper II
Neonatal illnesses	A postpartum woman who reported her neonate as having any neonatal illnesses within 28 days of childbirth	Paper II
Utilisation of healthcare services	The number of healthcare services used by a woman or a mother of the neonate to get treatment during pregnancy-related, postpartum, or neonatal illnesses.	Papers I, II, III
Out-of-pocket healthcare payment	A payment made by households to healthcare providers at the point of receiving healthcare services due to pregnancy-related, postpartum, or neonatal illnesses	Paper III
Catastrophic healthcare expenditure	Catastrophic healthcare expenditure was determined if out-of-pocket healthcare payments exceeding 10% of total household or 40% of non-food expenditure.	Paper III
Impoverishment	The process of becoming poor, or loss of wealth due to catastrophic healthcare expenditure.	Paper III

### Statistical analysis

Double data entry was done using EpiData version 3.1 software (EpiData Association, Odense, Denmark). In Papers I and II, for analysis of illnesses and use of healthcare services, pregnant women, postpartum women, and their neonates were used as the unit of analysis. Descriptive analysis was conducted using univariate analysis of one variable to describe the data and find patterns that exist within it, and then bivariate analysis was carried out to analyse any relationship between two different variables (Papers I, II, and III). Multivariate analysis was also

performed to analyse any relationship between three or more different variables and identify factors associated with outcome variables (Papers I, II, and III). As per the recommendation of Hosmer and Lemeshow, variables with  $P$ -value  $\leq 0.20$  in univariate analysis were used for multivariate analysis [92].  $P$ -value  $\leq 0.05$  was used as the cut-off point to determine significant association. The strength of associations was quantified using odds ratio (Adjusted Relative Risk - ARR) with corresponding 95% confidence intervals (CI). A Poisson regression model (Paper I) and Prentice, Williams, and Peterson's total time Cox-type survival model were used for analysis (Papers I and II), using STATA software version 15 (Stata Corp., LLC. College Station, Texas, USA) (see Table 4).

In Paper III, for analysis of financial risks, the household was used as the unit of analysis. The out-of-pocket healthcare payment was disaggregated by pregnancy-related, postpartum, and neonatal illness. The financial risk of seeking maternal and neonatal healthcare was estimated using the incidence of catastrophic healthcare expenditure, impoverishment, and poverty gap (Paper III). Annual catastrophic healthcare expenditure was determined at the threshold of 10% of total household expenditure, or 40% of household non-food expenditure. Impoverishment due to catastrophic healthcare expenditure was analysed based on total household expenditure and the international poverty line of  $\approx$  \$1.9 per capita per day (i.e. the poverty line is half the median household income of the total population).

The poverty gap was analysed, i.e. the ratio by which the mean income of the poor was less than the international poverty line of  $\approx$  \$1.9 per capita per day. The concentration curve was used to measure inequality in the distribution of total household expenditure, out-of-pocket healthcare payment, and utilisation of healthcare services. The further the curve is from the 45° line of equality, the greater is the inequality [90]. The logistic regression model was used for analysis (Paper III) using SPSS software, version 25 (SPSS Inc. Chicago, IL, USA), and Automated Development Economics and Poverty Tables (ADePT) software, version 6.06648, developed by World Bank experts ([www.worldbank.org/adept](http://www.worldbank.org/adept)) (see Table 4).

Table 4: Overview of statistical methods

Paper	Statistical methods used
Paper I Utilisation of healthcare services fails to meet the needs of pregnancy-related illnesses	<ul style="list-style-type: none"> <li>• Univariate analysis</li> <li>• Bivariate analysis</li> <li>• Multivariate analysis</li> <li>• Poisson regression model</li> <li>• Prentice, Williams, and Peterson's total time Cox-type survival model</li> </ul>
Paper II Incidence of postpartum and neonatal illnesses and utilisation of healthcare services	<ul style="list-style-type: none"> <li>• Univariate analysis</li> <li>• Bivariate analysis</li> <li>• Multivariate analysis</li> <li>• Prentice, Williams, and Peterson's total time Cox-type survival model</li> </ul>
Paper III Financial risks of seeking maternal and neonatal healthcare	<ul style="list-style-type: none"> <li>• Univariate analysis</li> <li>• Bivariate analysis</li> <li>• Multivariate analysis</li> <li>• A logistic regression model</li> <li>• Automated Development Economics and Poverty Tables (ADePT) software version 6.06648</li> </ul>

### Ethical considerations

This study was approved by the Institutional Ethical Review Board at Hawassa University, College of Medicine and Health Sciences (IRB/100/08), and by the Regional Committees for Medical and Health Research Ethics (REC) of western Norway (2016/1626/REK vest). Written permission was obtained from the Gedeo zone health department and the Wonago *wereda* (district) health office. Written informed consent was obtained from each woman or mother after she had received an explanation of the purpose of the study. The privacy, anonymity, and confidentiality of study participants were maintained. If a woman or neonate was found to have an illness during the pregnancy, postpartum, or neonatal periods, the data collectors attempted to link the patient with Health Extension Workers in the *kebele*.



## Results

### Paper I: Utilisation of health services fails to meet the needs of pregnancy-related illnesses in rural southern Ethiopia

We aimed to assess the incidence of and risk factors for illnesses among pregnant women and measure the use of health services. A prospective cohort study was conducted in three *kebeles* in rural southern Ethiopia among 794 pregnant women from May 2017 to July 2018. Each woman was followed every two weeks at home. A Poisson regression model and Prentice, Williams, and Peterson's (PWP) total time Cox-type survival model were used for analysis.

The incidence rate of at least one type of episodes of pregnancy-related illnesses was 93 per 100 pregnant-woman weeks (95% CI: 90.6, 94.2), with an average of eight episodes of illnesses per woman. Anaemia accounted for 22% (177 of 794 women), and hypertension for 3% (21 women of 794 women).

However, utilisation of health services for any illness episodes was only 8% (95% CI: 7.6, 8.9). The main reasons for not using health services were that the women thought the illness would heal by itself, women thought the illness was not serious, women could not afford to visit the health institutions, or women lacked confidence in the health institutions.

The risk factors for illnesses were having many previous pregnancies in her lifetime (ARR=1.42; 95% CI: 1.02, 1.96), having a history of stillbirth (ARR=1.30; 95% CI: 1.03, 1.64), having a history of abortion (AHR [Adjusted Hazard Risk]=1.06; 95% CI: 1.02, 1.11), and walking more than 60 minutes to access the nearest hospital (AHR=1.08; 95% CI: 1.03, 1.14). The risk factors for low use of health services are having a history of abortion (AHR=2.50; 95% CI: 1.00, 6.01) and walking more than 60 minutes to access the nearest hospital (AHR=1.91; 95% CI: 1.00, 3.63).

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Paper II: Incidence of postpartum and neonatal illnesses and utilisation of healthcare services in rural communities in southern Ethiopia

We aimed to assess the incidence of and risk factors for illness among postpartum women and neonates and measure the use of healthcare services. We visited 784 (99%) postpartum women eight times at home over the first 42 postpartum days and six times for their 772 (99%) neonates over the first 28 days. Prentice, Williams, and Peterson's (PWP) total time Cox-type survival model was used for analysis.

The incidence rate of at least one type of episodes of postpartum illnesses was 31 per 100 postpartum women-days (95% confidence interval [CI]: 30, 32) and 48 incidence of neonatal illnesses per 100 neonate-days (95% CI: 46, 50). Anaemia occurred in 19% of women (95% CI: 17, 22) and low birth weight (<2,500g) in 15% of neonates (95% CI: 13, 18).

However, only 5% of postpartum women (95% CI: 4, 7) and 4% of neonates (95% CI: 3, 5) were reported as utilising healthcare services. Reasons for not utilising healthcare services included a belief that the illnesses were not serious or would resolve on their own, little confidence in the healthcare institutions, and the inability to afford the cost.

Walking over 60 minutes to access healthcare was a factor for both postpartum illnesses (AHR=2.61; 95% CI: 1.98, 3.43) and neonatal illnesses (AHR=2.66; 95% CI: 2.12, 3.35). Birth weight  $\geq$ 2,500g was an identified as protective factor from neonatal illnesses (AHR=0.39; 95% CI: 0.33, 0.46). Compared with younger mothers, older mothers with sick newborns (AHR=1.22; 95% CI: 1.00, 1.50) or postpartum illnesses (AHR=1.40; 95% CI: 1.03, 1.89) were more likely to seek healthcare.

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### Paper III: Financial risk of seeking maternal and neonatal healthcare in southern Ethiopia

We aimed to assess the financial risk of seeking maternal and neonatal healthcare. A cohort study was conducted among 794 pregnant women, 784 postpartum women, and their 772 neonates from 794 households. The logistic regression model was used for analysis.

Approximately 93% (735) of pregnant women, 31% (244) of postpartum women, and 48% (369) of their neonates experienced illnesses. However, only 56 households utilised healthcare services. The median total household expenditure was \$527 per year (IQR=390: 370, 760).

The median total out-of-pocket healthcare payment among households that sought healthcare during maternal and neonatal illnesses was \$46 per year (IQR=46: 46, 92), with two episodes per household. The overall household budget's share of total out-of-pocket healthcare payments across quintiles was 19% and was highest among the poorest households. The poorer households paid more than the richer for healthcare during pregnancy and neonatal illnesses. However, the richer paid more than the poorer during postpartum illnesses.

Around 46% of households that sought healthcare faced catastrophic healthcare expenditure at the threshold of 10% of total household expenditure, or 74% of households, as defined by more than 40% of non-food expenditure, and associated with neonatal illness (ARR: 2.56, 95% CI: 1.02, 6.44).

Moreover, around 92% of households that sought healthcare were pushed further into impoverishment due to catastrophic healthcare expenditure. The poverty gap among households was 45 Ethiopian Birr per day (defined as an international poverty line of  $\approx$  \$1.9 per capita per day).

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## Discussion

### Methodological discussion

#### Study design

With the objective of measuring the incidence of illnesses, we employed a prospective cohort study design for all three papers (Papers I, II, and III). A cohort is a group of individuals, and a cohort study identifies and follows up groups without illness from exposure to outcome [93]. Such a prospective cohort study compares the incidence rates among the comparison groups (exposed and non-exposed) [77, 94]. In the following sections, I will discuss methodological issues that were encountered during the study.

A cohort of pregnant women who were attending antenatal care at health posts and who were without illnesses was selected and followed. Then, the exposures were measured before the onset of any illnesses. After we followed up on these pregnant women, we measured illnesses that occurred every second week. There was no additional intervention except the routine care provided by the health institutions. In line with previous studies, all the data were collected using regular periodic face-to-face interviewers and some measurements to assess the women's and neonates' health status.

Although we have assumed that pregnant women were free of illness when we first interviewed them, we cannot exclude the likelihood that some eligible pregnant women might have had previous illnesses. For example, it is likely that a woman with hypertension could have had this illness before we diagnosed it; however, it is likely that our method would capture such an illness. However, we could have missed some serious illnesses prior to our start of registration.

Exposure was assessed at the first meeting with the women. Therefore, for example, a pregnant woman classified as rich at the start of the follow-up could have been reclassified as poor if the household expenditure increased during the follow-up, as would occur in the case of

catastrophic healthcare expenditure (Paper III). However, in the case of such an event, we did not reclassify the wealth status; this occurred in only a few cases and is therefore unlikely to change our conclusions (Paper III).

Based on the findings of similar studies, cohort studies present a challenge in tracing study participants during the follow-up period [95]. Loss-to-follow-up (attrition bias) can be a problem for two main reasons: (1) if the attrition is for reasons unrelated to the outcomes, it tends to reduce the sample size, and outcome measures may be missed on those who are lost, thus affecting the power of the study; (2) if the attrition is for reasons related to the outcomes, it tends to affect the comparability of the exposure groups. Therefore, one of the unanticipated findings in this research was that there was loss-to-follow-up for some of the follow-up variables. This was due to unexpected social unrest in which more than one million people were displaced in the study area during the study period in 2017/18 [68]. Thus, this limited our ability to gain access to all women. However, the lost-to-follow-up rate was about 11%. To ensure that there was no systematic bias, we compared the characteristics or differences by wealth status between those who were lost-to-follow-up and those who remained in the study, and we found there was no significant difference ( $P$ -value  $<0.24$ ). Therefore, the lost-to-follow-up could not be related to the illnesses; however, it could have affected the sample size, as illnesses could be missed on those lost-to-follow-up participants, and could have under-powered our study.

### Statistical methods

In terms of statistical methods, in Paper I, some of the Poisson regression model estimates during illness analysis are different from the Prentice, Williams, and Peterson's (PWP) total time Cox-type survival model which was used for analysis. The Poisson regression model estimates also had a wider confidence interval than the Prentice, Williams, and Peterson's (PWP) total time Cox-type survival model. Furthermore, the Poisson regression model analysis of the use of healthcare services was not statistically significant. Therefore, the interpretation of the results was based on the Prentice, Williams, and Peterson's (PWP) total time Cox-type

survival model, as this model is a robust option for recurrent events, and caution should be used when interpreting the results from Poisson regression model based on count data [96].

### Sample size

Sample size refers to the number of participants included in a study [97]. One of the well-known challenges of a cohort study design is that it requires a sample size which should not be either too small or too big [98]. The power of a study can be improved in either the following factors: if the sample size, the alpha level, and the effect size (i.e. magnitude of an effect of interest) are increased, and/or if a random error is decreased [99]. Therefore, in this thesis, to increase the power during sample size estimates, we set the higher significance level (i.e. alpha level of 0.05), effect size (RR) of 1.65, and 95% confidence interval (CI) (i.e. the precision of the estimate of the magnitude of that effect) (Paper I). In addition, we used a combination of effect size, and the confidence interval, and *P-value* during reporting of statistically significant findings (Papers I, II, and III). However, because we studied fewer pregnant women than we had planned (Papers I, II, and III), our study could be under-powered, with a lower chance of getting significant results, and could have a wider confidence interval and larger *P-value* ( $>0.05$ ) in detecting the difference between the comparison groups (exposure groups). Therefore, our estimates could have been influenced and should be interpreted with caution.

In this thesis, the effects of some findings are not statistically significant between socio-demographic factors and illnesses. Non-significant results (negative findings) can occur for at least two reasons: (1) the effect might exist, but it could have been overlooked because the evidence may not be sufficiently strong, and (2) the effect could be smaller than expected and might be considered negligible or absent [100]. Therefore, these negative findings have some limitations that might be introduced due to chance or other factors [101]. In Paper I, to analyse how much we overlooked an effect although it really exists, and to analyse the probability of how much a significant result could have been obtained for an effect size that really exists in a given statistical model and sample size, we did a post-hoc power analysis, assuming

pregnancy-related illnesses as the outcome and walking distance to a health post, gravida, and parity as exposure. However, the power was 98% (walking distance to a health post), 44% (gravida), and 44% (parity). Yet, some of our non-significant results could be the result of inadequate power due to the small sample size. Therefore, in our case, to avoid reporting bias that arises due to reporting only positive findings, we reported all types of positive or negative results (Papers I, II, and III).

In this thesis, a two-stage cluster sampling was carried out, where, at the first stage, we selected the *kebeles* randomly, and at the second stage, we interviewed all of the pregnant women in those *kebeles* (Paper I). This is because a cluster sampling design starts with a sampling of clusters and may end with a sampling of units [102]. To find the adjustment of survey sample size due to sampling methods (i.e. cluster sampling), we calculated the design effect; assuming the ratio of the variance around the prevalence in a cluster design over variance in a simple random sample (SRS), the calculated design effect was 1.5 (Paper I). In addition, to look at the data already collected and find patterns of the power of this study, we also did a post-hoc power analysis, and some of the findings showed that the power for pregnancy-related illnesses was 98% (Paper I); however, the corresponding power for postpartum illnesses was 72% (Paper II) and 71% for neonatal illnesses (Paper II). Therefore, the findings of design effect indicated that our sample size could have been increased by half, and the findings of post-hoc power analysis indicated that our study could have been under-powered, which might be due to loss-to-follow-up. Thus, our estimates could have a wider confidence interval and larger  $P$ -values ( $>0.05$ ). Therefore, the findings should be interpreted within this context, and we recommend further study to be conducted using a larger sample size.

In general, even if we studied fewer pregnant women than we had planned, we recruited about 91% of eligible pregnant women from the three *kebeles*, and we studied more than 80% of recruited pregnant women (i.e. who completed the study) (Paper I). Despite that, if the sample size of this study had been increased, the chance of observing more significant results could

have increased, and the confidence interval for the factors associated with illnesses could have narrowed. However, significant results would remain significant.

### Internal validity

Internal validity refers to the ability of a study to measure what it aims to measure without bias [103]. Although internal validity implies the differences in illnesses between the groups being compared due to the exposure under study [103], it could be affected by *selection bias*, *measurement bias*, and *confounding* [104]. Internal validity depends on both the procedures of a study and how it is performed. Bias is a type of systematic error by which effect estimates differ from the truth [104].

### *Selection bias*

This is a systematic source of errors that result from the process used to select subjects for a study (i.e. sampling bias) and from factors that influence study participation (i.e. participation bias) [105]. In this thesis, to overcome selection bias, we tried to make our thesis representative by recruiting as many pregnant women as possible; we recruited about 91% of eligible pregnant women, and we studied more than 80% of the recruited pregnant women (Paper I). We also recruited both the comparison groups (exposure groups) from the same source population. However, selection bias could have occurred during the selection of pregnant women because we recruited only those who attended two or more antenatal care visits (Paper I). This is because, among pregnant women who received two or more antenatal care, about three-quarters were screened for blood pressure, a blood sample was taken from 73%, and a urine sample was taken from 66% of the pregnant women for diagnosis [106]. Therefore, we used these as initial recruitment criteria in which we assumed that at least these pregnant women were free of illness when we first interviewed them, as they had already been screened during their antenatal care visits. However, this recruitment overlooked those who attended fewer than two antenatal care visits or who did not attend such services at all (i.e. these pregnant women were excluded).



Therefore, sampling bias could have happened, and the comparison groups could not be truly comparable and the results could under-estimate the number and incidence rates of illness.

Furthermore, participation bias could have occurred due to unanticipated loss-to-follow-up which affected the completeness of follow-up variables between comparison groups. Thus, only those pregnant women with complete data were included, while those who were not followed-up for the full study period were excluded. Therefore, the risk of some selection bias in this cohort could not be excluded, and the findings must be interpreted within this context.

#### *Measurement bias*

This is a form of a systematic source of errors that result when the outcome or exposure variables are measured, collected, or interpreted inaccurately [107]. Measurement bias comprises *self-reporting bias* (i.e. social desirability, and recall or reporting bias), *information bias* (i.e. observer or recorder bias) and *confirmation bias* [107].

#### *Self-reporting bias: Social desirability bias*

This is a systematic source of errors in which there is a tendency for the respondent to answer questions in a way that they think would be viewed as socially acceptable or favourable by others [107]. In this thesis, the potential effects of social desirability bias were taken into account during the registration of symptoms. This is because the responses from the women could have been inclined towards their self-interest in which the women could over-report the symptoms, exaggerating so that their situation seemed worse, or they could under-report the symptoms, downplaying their problems. Nevertheless, we used combined strategies; so as not to place undue pressure, and to avoid priming women to respond in socially acceptable ways, we briefed the interviewees about the study, and there were no right or wrong answers. In addition, we conducted a one-to-one interview at the women's home, using interviewer-administered questionnaires with a close-ended and exhaustive list of choice items.

*Self-reporting bias: Recall bias*

This is a systematic source of errors that occur when participants do not remember previous events or experiences of illnesses accurately or forget the details [93]. In this thesis, the potential effects of recall bias were also taken into account because the accuracy of memories could be influenced due to recall bias during the registration of symptoms. This is because women could be mistaken or misremember illnesses or events. Besides, as some exposure status could be transient and periodically recalled, recording of the exposure could be stated inaccurately rather than the actual situation. Therefore, such recall bias could lead to over- or under-reporting of socioeconomic and illness estimates and could reduce the precision of the estimates, and thereby under-power the study.

However, we used different strategies to reduce the risk of recall bias; we used clear and well-defined questions, we chose an appropriate data collection method (i.e. face-to-face interview with a sufficiently short follow-up visit time), and we asked the women about new illnesses or events. In addition, we described the women's and neonates' health status either as the presence (yes) or absence (no) of symptoms during the interview. Maternal recall for age was another challenging limitation. Such recall bias was most likely to attenuate the true associations between age and illnesses or events. Therefore, we used local calendar memory aids to encourage recall of past events, in order to limit inaccuracies.

*Information bias (observer or recorder bias)*

This is a systematic source of errors that arise in either the measurement or recording of exposure or outcome variables [107]. In this thesis, possible information bias was taken into account. For example, information bias could have occurred while interviewing the study subjects, registering symptoms, taking vital signs, measuring haemoglobin levels, and measuring the blood pressure of the women, as well as measuring the length and weight of the neonates. Moreover, information bias could also be introduced as we relied on subjective self-reports of signs or symptoms using a questionnaire that was not supplemented by further

confirmation from a clinical examination, laboratory reports, or medical records, as the World Health Organization recommends. Also, we only investigated a limited range of disorders. Therefore, the difference in illness between comparison groups could not be comprehensively identified and this could influence the interpretation of the data. There could also be over- or under-estimation of associations.

However, we used a clear, well-defined and focused research question, and we followed-up the women and their neonates until specified endpoints (i.e. until the pregnant women give birth, the neonate up to 28 neonatal days of life, and the women who gave birth for up to 42 postpartum days after birth). Then, we assessed the defined outcomes by not revealing or concealing the exposure status to either the interviewer or the women. We measured the primary outcome (illnesses) by collecting original data using adopted and pre-tested questionnaires and well-trained interviewers and experienced supervisors (Papers I, II, and III). Moreover, the frequency and completeness of each visit were also recorded. Furthermore, we used standard operating procedures for the measuring instruments (i.e. for blood pressure, haemoglobin, temperature, and weight). We also did repeated measurements during follow-up visits.

Regarding information bias in Paper III, it was noted that out-of-pocket healthcare payments and household total expenditures were not normally distributed; the curve was skewed to the right, as there were many small and zero values and a few very large values. Furthermore, in Paper III, we did not identify those who did not use healthcare services since they could not afford healthcare payments and did not incur out-of-pocket healthcare payments.

The findings of Paper III could also be exaggerated. This was because the out-of-pocket healthcare payments used in the analyses were the sum of the three categories from the same household (i.e. pregnant women, postpartum women, and neonates), the summation of all repeated visits, and we reported these on an annual basis. Furthermore, all possible expenditures and all out-of-pocket healthcare payments from households could not be covered within the questionnaire. Paper III also focused only on out-of-pocket healthcare payments, and it could

not measure the impact of opportunity costs, such as income losses during illnesses, socioeconomic shocks, or deaths.

Despite that, as the recall periods differed for different types of goods, we used reasonable recall times to record out-of-pocket healthcare payments and expenditures. For example, for the goods that were purchased infrequently, we used a sufficiently long period, so that the consumption was representative of the reference period (i.e. within a year). A short period was used for the goods that were purchased and consumed often, so that households could remember expenditures and consumption with reasonable accuracy. Moreover, we measured the out-of-pocket healthcare payments during each visit for illness registration.

#### *Confirmation bias*

This is a systematic source of errors in which there is human judgment when the diagnosis is done, based on the researcher's preconceptions, beliefs, or preferences. That means confirmation bias may arise at the moment when a researcher understands, filters, judges, and reports the responses to confirm the intended outcome [107]. In this thesis, as we did not use a further medical diagnosis, our registration of self-reported signs or symptoms could be subjected to confirmation bias. Thus, confirmation bias could have caused inaccurate identification and labelling of illnesses. To enhance the likelihood of getting the same results (i.e. the consistency of the responses), we did several repeated visits using an exhaustive list of symptoms in the questionnaire.

#### *Confounding*

Confounding refers to an extraneous factor that mixes the effects of the exposure with the effect of a third variable which is associated with both the exposure and outcome variables.

Confounding arises when the association is due to three factors: the exposure, outcome, and a third factor [108, 109]. Confounding may also increase if the exposure status is correlated with other factors. However, it can be addressed in either the design or analysis [108, 110]. In this thesis, we accounted for the main potential confounding factors in the analysis, and the effect

measures were presented as unadjusted and adjusted estimates. For example, the effects of women's age and parity were controlled for socioeconomic factors associated with pregnancy-related illnesses (Paper I). The effects of women's age at first birth and history of abortion were also controlled for socioeconomic factors associated with the use of healthcare services during pregnancy-related illnesses (Paper I). In addition, the effect of walking distance to the nearest health post was controlled for socioeconomic factors associated with postpartum illnesses (Paper II).

Moreover, the effects of women's age at first marriage and household wealth index were controlled for socioeconomic factors associated with neonatal illnesses (Paper II). However, the observed effect estimates could be not reflective of the true association between illnesses and the socioeconomic factors and could be under-estimated. For example, young women could be different in other aspects from old women and could be less likely to develop illnesses because of this, rather than because of the women's age. Nevertheless, in the analysis, we employed multivariate techniques to address this issue, and we used adjusted estimates for the known confounding factors.

However, despite these measures taken, the residual or unknown or immeasurable confounding factors cannot be addressed in either the design or analysis stage [111]. In this thesis, there could be the possibility of confounding factors that we did not assess, or that we missed. For example, individual, community, and societal factors, and the behavioural lifestyle of the women, could also have an impact on women's and neonates' health. Therefore, the observed associations with illnesses could be stronger or weaker, but it is unlikely that they were solely due to either socioeconomic or unmeasured or both socioeconomic and unmeasured factors.

### *Chance*

This is a non-systematic source of errors that refers to random error which may affect the statistical precision of a study arising from sampling variability [102]. In this study, as our sample size was smaller than expected, random error and variability of the data could be higher

than we noted. As a result, the ability to detect a statistically significant difference in illness between comparison groups could be reduced (i.e. there could be no significant difference between the two comparison groups), there could be a wider confidence interval and larger  $P$ -value ( $>0.05$ ), and thus the effect measures could be under-estimated. However, we ruled out the role of chance using a 95% CI to quantify the random error associated with estimate and  $P$ -value  $<0.05$  to determine statistical significance using different statistical models, including the Poisson regression model (Paper I), Prentice, Williams, and Peterson's total time Cox-type survival model (Papers I and II), and logistic regression model (Paper III).

### *External validity*

External validity (generalisability) refers to the extent to which the study findings can be applied to wider settings [104]. The external validity of a study depends on the following four issues: (1) internal validity, which is the pre-condition for it, (2) sample size, (3) recruitment, and (4) credibility of the overall evidence on the estimates. In this thesis, we recruited only those pregnant women who attended two or more antenatal care visits at health posts in their respective *kebeles*, but not those who had fewer than two antenatal care visits or did not attend such services at all. Thus, our study could be representative only of those who attended two or more antenatal care visits; however, it could not be fully representative of those who had fewer than two visits or who did not attend antenatal care services at all. This is important because pregnant women not attending antenatal care could have a higher incidence of illnesses and lower use of health services. Therefore, such an under-representation could affect descriptive measures such as incidences and proportions. In addition, the effect measures and associations could be different in illness between comparison groups. Nevertheless, the proportion of the number of pregnant women in the study over the number of eligible pregnant women from the three *kebeles* (Papers I, II, and III) was in agreement with birth registry studies in southwest Ethiopia, in which the coverage of maternal health services was approximately 75% [112].

It is also true that the findings may not be generalisable throughout a country in which diversified ethnic and cultural differences are common, like in Ethiopia. However, in this thesis, the study populations are typical rural residents, and the way of living in Wonago district is typical of and consistent with the rest of the rural areas in southern Ethiopia. Therefore, we are fairly confident that the findings could be reasonably generalisable to other settings in southern Ethiopia with similar socio-demographic characteristics. To the best of our knowledge, this study could be the first of its kind in Ethiopia that could make contributions to understanding the comprehensive description of illnesses, the use of healthcare services, and the related financial risks in rural communities; it should also shed light on the challenges in improving maternal and neonatal health and healthcare-seeking in which a community-based continuum of care framework for the management of maternal and neonatal illnesses was implemented.

## Discussion of the main findings

In the research for this thesis, the general objective was to provide data that could support improvements in maternal and neonatal health and healthcare-seeking in rural communities (*kebeles*) in southern Ethiopia. We observed a high burden of incidence of illnesses during the pregnancy, postpartum, and neonatal periods. Although these symptoms signal potentially dangerous illnesses, which need to be properly diagnosed and treated, unfortunately, very few of these women and their neonates sought treatment through healthcare services. We showed that socio-demographic factors were associated with both illnesses and the use of healthcare services. In particular, behavioural and socioeconomic factors were the main reasons for not utilising healthcare services. However, financial risk was high for households that sought maternal and neonatal healthcare. As a result, those few households that sought healthcare were pushed into severe impoverishment. There was also high health inequity between richer and poorer households in terms of the household budget's share of the total out-of-pocket healthcare payments.

In this thesis, illness refers to personal ailments that can occur among women and their neonates [85]. The burden of maternal and neonatal illnesses in rural communities could pose a challenge for illness prevention and control strategies and remain a leading cause of death in women and their neonates [5]. Our findings in this research in terms of improving maternal and neonatal health are in line with the World Health Organization's recommendations of key essential interventions at the community level to the mother during pregnancy and the postpartum period, and to the neonate soon after birth; this includes an assessment of maternal and neonatal well-being, and detection of illnesses at all stages of pregnancy, and the postnatal and neonatal periods [113]. Moreover, studies in Bangladesh, India, and Pakistan suggest that community-based home visits helped in early detection of maternal and neonatal illnesses, reduced maternal and neonatal deaths by 30% to 61%, and in turn, improved maternal and neonatal health in low- and middle-income countries [114]. Even though it is difficult to get accurate diagnoses in this community-level study, perceived illness (self-reported ill-health) could provide evidence of



women's and neonates' experiences of illnesses in a place where women are not able to access healthcare services easily and where healthcare-seeking is poor.

Despite the implementation of the Sustainable Development Goal Number-3 to promote the well-being of women, released by the United Nations in 2015 [62], in Paper I, we reported a high burden of incidence of pregnancy-related illnesses among rural pregnant women. This could be explained by the fact that our study constituted a cohort study with multiple visits to pregnant women's homes, and the other studies were cross-sectional. Although many pregnancy-related illnesses were regarded as minor by pregnant women, potentially severe conditions, such as hypertension, anaemia, and vaginal bleeding were also common (Paper I), as was explained in a study from Tanzania [115]. Moreover, we reported a higher rate of pregnancy-related illnesses than from previous studies in Ethiopia [20], India [116], and Pakistan [117], and such illnesses often needed treatment by skilled healthcare staff. However, the incidence of pregnancy-related illnesses was similar to a population-based study in Sri Lanka [118]. The Sri Lankan study showed that illnesses that were considered as minor were judged not to be minor for pregnant women.

The risk factors related to both the patient and to lack of healthcare use have been pointed out in many studies. For instance, the use of healthcare services is dependent on women's socioeconomic and demographic environment [30], such as the woman's age, educational status, occupation, access, and travel time to a health facility [119]. Illnesses among pregnant women are also associated with both increased maternal deaths and stillbirths [120, 121]. Published research often advocates that educating women about illnesses could reduce delays and improve healthcare-seeking. This is because not seeking healthcare may aggravate the illness or may lead to death, unless effective treatment was received. Unfortunately, there is limited evidence about how such information works, without other interventions.

In Paper II, about postpartum and neonatal illnesses, we also noted a high burden of incidence of postpartum and neonatal illnesses among rural communities, and among those postpartum

women who walked for a long time/distance to access healthcare, and among those neonates who had low birth weight. However, the rate of postpartum illnesses in our study was lower than that found in studies from Pakistan [122] and India [123]. This gap could be due to differences in the study population, study design, and study settings. The studies from India and Pakistan included postpartum women either from home or healthcare facilities, whereas we did multiple visits at home and focused on both severe and minor forms of postpartum illnesses. Multiple socioeconomic and demographic factors, such as poverty, are linked with increased risk of postpartum illnesses, while geographic location, household wealth status, and the mother's marital status, age, education, and occupation are also associated with neonatal illnesses [6]. Mothers' and caregivers' perceptions about these illnesses and the cost of treatment can influence their healthcare-seeking behaviour [6], which in turn affects mothers' access to healthcare for neonatal illnesses.

Nevertheless, in this thesis, even though we reported that the rate of illnesses was high during the pregnancy, postpartum, and neonatal periods (Papers I and II), few of the households sought or received care from available healthcare facilities in the study area. This is explained in that a low rate of healthcare-seeking was associated with the mother's perception of the severity of symptoms, and the mother's low awareness about the treatment of the symptoms and ability to recognise or identify symptoms [124]. The findings from this research were similar to those reported in an Australian longitudinal study, in which many pregnant women had non-severe illnesses, but 68% did not utilise healthcare services [125], and in Sri Lanka, 90% did not utilise healthcare services [118]. A possible explanation is that delay in seeking healthcare may result from underlying household poverty, which may preclude the use of healthcare services and which may be the main contributing factor [126]. The findings reported in this thesis emphasise the critical need to identify and address barriers to healthcare-seeking, assess the quality of care for illness identification using Health Extension Workers, and take public health measures (Papers I, II, and III).

In spite of how the Health Extension Programme has enabled Ethiopia to achieve encouraging improvements in maternal and neonatal health, there are still challenges that remain to be addressed [51]. The challenges that hinder the achievement of the programme are related to the efficiency of the Health Extension Workers [51]. Even though the Health Extension Workers were intended to spend more than 70% of their time in making home-to-home visits, they have become static in that they spent less time than this in the community [51]. Moreover, Health Extension Workers have no adequate pre-service training that enables them to identify maternal and neonatal illnesses [51]. Therefore, the success of improving maternal and neonatal health and healthcare-seeking depends on strengthening primary healthcare units, including in illness identification and management, and improving the use of healthcare services, which is critical for further reductions in maternal and neonatal death. Together, the findings of this research suggest that further efforts are needed to strengthen the provision of maternal and neonatal healthcare at the community level. The health extension system, combined with the local Women's Development Groups (WDGs) and networks of the Health Development Army (HDA) in their communities (*kebeles*), gives us an opportunity to improve the healthcare-seeking habits of mothers and to identify ill women and neonates.

In Paper III, we reported that, even though few households were utilising available healthcare services, the financial risk of seeking maternal and neonatal healthcare was high, and many of these households were pushed into severe impoverishment. These findings were consistent with a study from Zimbabwe [127]. The report from the World Health Organization also shows that poverty was associated with low healthcare-seeking [57]. Furthermore, unless the out-of-pocket healthcare payments are reduced to 15-20% of total household health expenditures, financial catastrophe and impoverishment still remain a challenge [57].

The findings concerning impoverishment were also comparable with other studies reported from Rwanda, [128], Kenya [129], Ghana [130], and Uganda [131]; however, the findings were not consistent with a previous study in Ethiopia [132]. This difference could be because this study's participants had chronic illnesses, while we were following acute illnesses among mothers and

their neonates. Moreover, the 2% of households that were pushed into poverty in our research corresponds to the economic impoverishment of nearly 22,000 people in our study area, the Gedeo zone. Such impoverishment due to out-of-pocket healthcare payment, in turn, can impact health and affects healthcare-seeking. As a result, impoverished households could not use healthcare services, regardless of their quality, if they were not affordable and/or not accessible [133].

Consequently, the lack of financial health protection in the study area may indicate that the financial burden is heavier among the poorest households, and this has implications for the consumption of basic necessities. This might be one of the reasons why poor households allocated a greater share of their household budget to food compared to rich households [134]. As a result, because inability to make out-of-pocket healthcare payment limits the choice to seek healthcare during illness, it could be challenging to achieve universal healthcare coverage. Nevertheless, there is some evidence that financial health protection improves healthcare-seeking and in turn that could improve patient management. For example, a large intervention study in southern Ethiopia indicated that by improving access to good quality services to mothers and their neonates near their homes, maternal deaths were reduced by about 60% [133]. A further factor is that the vicious cycle of burdens of poverty and high illness often results in poverty aggravating the burden of illnesses, while people with heavy burdens of illnesses experience exacerbated poverty [71]. Therefore, the evidence from this thesis research could help to inform local, regional, and national policy decision-makers and could lead to public policy changes and improve maternal and neonatal health and healthcare-seeking. In turn, the findings could have the potential to transform lives for the better. This could be achieved by using Health Extension Workers, if they received additional training on how to identify and manage maternal and neonatal illnesses.

Given the interconnected parts of the conceptual framework, illnesses at different phases are connected with healthcare-seeking and are influenced by socio-demographic factors and financial constraints when accessing institutional services (Paper III). Together with the

conceptual framework, we used a ‘continuum of care’ framework that helps to deliver an integrated system of care for women-children pairs in a coherent and timely manner at the household-community level [8]. The continuum of care connects the essential maternal, newborn, and child healthcare services and is critical for improving maternal and neonatal health and healthcare-seeking [10]. In addition, the continuum of care concept helped us as a guide to track the women and neonates over time.

We focussed on identifying problem areas among pregnant women, who were followed up in the first phase (Paper I), and then in the second and third phases, postpartum women and their neonates were also followed (Paper II). In the three phases, out-of-pocket healthcare payments were also measured, together with the assessment of illnesses and the use of healthcare services (Paper III). Therefore, our method of using a continuum of care approach to identify the problem areas (Papers I, II, and III) is comparable with a conceptual framework that is useful in understanding the interconnected health-related issues in terms of improving maternal and neonatal health and healthcare-seeking. In addition, the continuum of care presents the linkages in between, on the one hand, maternal and neonatal illnesses and use of healthcare services in community settings, and on the other hand, financial risks for seeking maternal and neonatal healthcare services [135].

Our method of registration of symptoms (Papers I, II, and III) involved the repeated registration of symptoms during the pregnancy, postpartum, and neonatal periods but was not supplemented by further diagnosis, as the World Health Organization recommends. Our study followed the World Health Organization’s template for how to assess the incidence of illnesses during the pregnancy, postpartum, and neonatal periods [5]. Consequently, the World Health Organization’s template could be expanded, and one possibility is to include questions about the use of healthcare services. Furthermore, our study concluded that there was room to improve the support that the healthcare system provided, by integrating the management of maternal and neonatal illness. It was stated that this could be achieved through improving the knowledge of Health Extension Workers involved in managing maternal and neonatal healthcare in health

posts [136]. This step could help to reduce maternal and neonatal mortality from illnesses [137]. In this regard, therefore, our community-based illness study methods could be employed for early detection and could help to translate the findings into action at the community level, in order to improve the health of mothers and their neonates. Therefore, to ensure better implementation of the findings of this thesis research, more detailed studies involving patients or the public are needed [138].

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## Conclusion and recommendations

### Conclusions

In terms of our general objective to provide data that could support improvements in maternal and neonatal health and healthcare-seeking, we observed a high burden of maternal and neonatal illnesses and poor healthcare-seeking in rural communities (*kebeles*) in southern Ethiopia. The conclusions for each of the specific objectives are presented as follows:

Objective 1: We aimed to assess the incidence and risk factors for pregnancy-related illnesses among pregnant women and to measure utilisation of healthcare services (Paper I); we concluded as follows:

- We observed a high burden of incidence of pregnancy-related illnesses in rural communities of the Wonago district in southern Ethiopia.
- Unfortunately, very few of these pregnant women utilised healthcare services.
- This research showed that the risk factors of pregnancy-related illness were having many previous pregnancies in a lifetime, having a history of stillbirth and abortion, and walking for a long time to access healthcare.
- Having a history of abortion was also a risk factor for low use of healthcare services.
- Reasons for not utilising healthcare services also included a belief that the pregnancy-related illnesses were not serious or would resolve on their own, little confidence in the healthcare institutions, and the inability to afford the cost.

Objective 2: We aimed to assess the incidence of and risk factors for illnesses among postpartum women and neonates, and to measure utilisation of healthcare services (Paper II); our conclusions are:

- We noted a high burden of incidence of postpartum and neonatal illnesses. Unfortunately, few of these postpartum women and their neonates sought treatment through healthcare services.

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- Walking for a longer time to access healthcare was a risk factor for postpartum and neonatal illnesses.
  - The low birth weight of the neonate was also a risk factor for neonatal illnesses.
  - Compared with younger mothers, older mothers with ill neonates or postpartum illnesses were more likely to seek healthcare.
  - Reasons for not utilising healthcare services included a belief that the postpartum or neonatal illnesses were not serious or would resolve on their own, mothers had little confidence in the healthcare institutions, and financial constraints.

Objective 3: We aimed to assess the financial risk of seeking maternal and neonatal healthcare (Paper III), and our conclusions are:

- The financial risk was high for mothers who sought maternal and neonatal healthcare
- Those few households that sought healthcare were pushed into severe impoverishment due to catastrophic healthcare expenditures.
- There was also a high health inequity in the household's health budget share due to out-of-pocket healthcare payments.



## Recommendations

Based on these conclusions, the recommendation concerning the general objective is that policymakers should give greater emphasis to improving maternal and neonatal health and healthcare-seeking, and to effectively dealing with factors that contribute to illnesses and poor healthcare-seeking in rural communities (*kebeles*). The recommendations for each of the specific objectives are presented as follows:

Objective 1: We aimed to assess the incidence and risk factors for pregnancy-related illnesses among pregnant women and to measure utilisation of healthcare services (Paper I), and we recommended actions that should be taken as follows:

- The provision of primary healthcare should be strengthened, including improved identification and management of illness in pregnant women.
- The provision of services should be enhanced to encourage and ensure that pregnant women seek and receive appropriate and timely healthcare.
- The maternal health programmes for pregnant women should give priority to and target those at most risk of pregnancy-related illnesses and with low use of healthcare services.
- The maternal health programmes for pregnant women should provide a basic integrated continuum of care in identifying, managing, treating, and referring pregnancy-related illnesses at the household-community level, using the Health Extension Programme.

Objective 2: We aimed to assess the incidence of and risk factors for illnesses among postpartum women and neonates and to measure utilisation of healthcare services (Paper II), and we recommended actions that should be taken as follows:

- The provision of primary healthcare should be strengthened, including improved identification and management of illness in postpartum women and neonates.
- The provision of services should also be enhanced to encourage and ensure postpartum women and their neonates to seek and receive appropriate and timely healthcare.

- The maternal and neonatal health programmes should give priority to and target rural communities (*kebeles*) with a high incidence of postpartum and neonatal illnesses and low use of healthcare services.
- The maternal and neonatal health programmes should provide a basic integrated continuum of care to those at risk of postpartum and neonatal illnesses at the household-community level, using the Health Extension Programme.

For policy

- The efforts of the Ministry of Health should be directed towards strengthening the health system to enable it to provide a continuum of care in identifying, managing, treating, and referring maternal and neonatal illnesses, using the Health Extension Programme.
- The non-healthcare-seeking behaviour is not only the result of difficulties with access but also the women's beliefs about health and illness. Therefore, informing and teaching mothers and women about the use of health services might be the key to improving health. This is because informed women may understand or have knowledge about when to seek healthcare services and how important seeking support is to their own and their neonate's current and future health.

Objective 3: We aimed to assess the financial risk of seeking maternal and neonatal healthcare (Paper III), and we recommended the following actions that should be taken:

- Maternal and neonatal health programmes should consider and give priority to the issue of health inequity when setting priorities, in order to address the lack of fairness experienced by poor and rural women in maternal and neonatal health.

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For policy

- Health inequities should be reduced by using mixed government policy action on the social determinants of health, including teaching women, and improvement of the socioeconomic status of the households.
- The Ministry of Health should intensify its actions in order to tackle the root causes of ill-health and health inequities.
- While these policy changes are being made, mothers and neonates should get access to prepayment in order to tackle the trap of a vicious circle of illnesses and poverty, and to achieve the goal of universal healthcare coverage.
- In addition, financial risk-pooling mechanisms would be useful in order to fund healthcare services for every mother and her neonate who is covered. It is critical to develop measures or interventions to remove or reduce financial risk for the poorest rural households.

For research

- Assessing the knowledge and skills of Health Extension Workers in identifying, managing, treating, and referring ill women and neonates and giving a reasonable level of healthcare could constitute a productive area for further research.
- The impact of opportunity costs, such as income loss during illnesses, and socioeconomic shocks, or death should be assessed.
- Finally, although the global studies and attention are pointed towards maternal and neonatal death, data on maternal and neonatal illnesses are almost nonexistent. Therefore, the paucity of data on maternal and neonatal illness is equally important, and more community-based data are essential to achieving improved maternal and neonatal health and healthcare-seeking.

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Original articles I-III: Supplementary information, and Appendices

Paper I



## RESEARCH ARTICLE

# Utilisation of health services fails to meet the needs of pregnancy-related illnesses in rural southern Ethiopia: A prospective cohort study

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## Abstract

Although maternal survival has improved in the last decades, evidence on illnesses and the use of health services during pregnancy remains scarce. Therefore, we aimed to assess the incidence and risk factors for illnesses among pregnant women and measure the use of health services. A prospective cohort study was conducted in three kebeles in rural southern Ethiopia among 794 pregnant women from May 2017 to July 2018. Each woman was followed every two weeks at home. Poisson and survival regression models were used for analysis. The incidence rate of episodes of illnesses was 93 per 100 pregnant-woman-weeks (95%CI: 90.6, 94.2), with an average of eight episodes of illnesses per woman. Anaemia accounted for 22% (177 of 794 women), and hypertension 3% (21 women of 794 women). However, utilization of health services for any illness episodes was only 8% (95% CI: 7.6%, 8.9%). The main reasons for not using health services were that the women thought the illness would heal by itself, women thought the illness was not serious, women could not afford to visit the health institutions, or women lacked confidence in the health institutions. The risk factors for illnesses are having many previous pregnancies in life time (ARR = 1.42; 95%CI = 1.02, 1.96), having history of stillbirth (ARR = 1.30; 95%CI = 1.03, 1.64), having history of abortion (AHR = 1.06; 95%CI = 1.02, 1.11), and walking more than 60 minutes to access the nearest hospital (AHR = 1.08; 95%CI = 1.03, 1.14). The risk factors for low use of health services are also having history of abortion (AHR = 2.50; 95%CI = 1.00, 6.01) and walking more than 60 minutes to access the nearest hospital (AHR = 1.91; 95%CI = 1.00, 3.63). Rural Ethiopian pregnant women experience a high burden of illness during pregnancy. Unfortunately, very few of these women utilize health services.

## Background

In 2016, the United Nations reported that maternal survival has improved in the last decades [1]. However, there is scarce evidence on the occurrence of illness among pregnant women



analysis, decision to publish, and preparation of the manuscript.

**Competing interests:** The authors have declared that no competing interests exist.

and their subsequent use of health services. In fact, one woman dies out of 20 women who suffer from illnesses during pregnancy. Thus, it is critical to obtain more precise estimates of illness burden during pregnancy from low resource settings [2].

Although ensuring healthy lives and promoting the well-being of women constitutes one of the major agenda items in Sustainable Development Goal Number 3 [3], the illness burden in developing countries among pregnant women remains high [4]. Globally, 10 to 20 million women suffer from pregnancy and childbirth-related illnesses annually [5]. Approximately 25% of pregnant women in developing countries [6] and 14% in Ethiopia in 2013 reported at least one type of illness during pregnancy [7].

Appropriate and timely healthcare-seeking and use of health services are essential for healthy living. The utilization of health services for illnesses during pregnancy is dependent on the women's socioeconomic and demographic environment [8], such as the woman's age, educational status, occupation, access, and travel time to a health facility [9]. Illnesses among pregnant women are associated with both increased maternal deaths and stillbirths [10,11]. In 2017, 56 million pregnant women experienced spontaneous abortion globally, and 49 million of these were in low-income countries [12]. In Ethiopia, in 2017, the rate of spontaneous abortion was 28 per 1000 women [13]. In 2015, the global number of stillbirths was estimated to be 2.6 million [13], and Ethiopia accounted for 4% of these (97,000 stillbirths) [13]. In addition, approximately 42% of pregnant women in developing countries were estimated to suffer from anaemia in 2017 [14], and 25% of Ethiopian pregnant women had anaemia [15]. Although iron-folic-acid supplementation is recommended for prevention or treatment of anaemia to all pregnant women who give birth [16], limited data exist concerning the uptake of iron-folic-acid supplementation during the antenatal and postpartum period from Ethiopia [15]. Hypertension is also common during pregnancy and occurs among 10% of pregnant women globally [17] and 6% in Ethiopia [18].

The causes and burdens of illnesses during pregnancy and the use of available health services in Ethiopia have not yet been well described. Therefore, we aimed to assess the incidence and risk factors for illnesses among pregnant women in rural communities in southern Ethiopia and measure the use of health services.

## Materials and methods

### Study design

A prospective cohort study was carried out among 794 pregnant women attending antenatal care (ANC). In 2016, the proportion of pregnant women attending at least one antenatal care in Ethiopia was 62% [19]. The healthcare system in Ethiopia is organized based on the type of care provided. For example, primary healthcare comprises one primary care unit (health centre) with five health posts, secondary healthcare includes zonal and regional hospitals, and tertiary care includes a central and teaching hospital. Primary healthcare utilizes the health extension package as an approach that focuses on communicable diseases, maternal health, common nutritional disorders, hygiene, and environmental health. Maternal and child healthcare, immunization against childhood illnesses, and family planning and reproductive health, infectious diseases, including tuberculosis, malaria and control of sexually transmitted infections and HIV/AIDS, are also critical areas to address. Pregnant women primarily use health extension workers at health posts. If the case is serious, the health post may refer them to a health centre.

According to the national antenatal care guidelines in Ethiopia, a focused ANC visit is advised to take place at least four times during a pregnancy. The main components of antenatal care include protection at birth from tetanus, blood pressure measurement, nutritional

counselling, iron-folate supplementation, and information about the danger signs of pregnancy complications [19].

In 2013, more than 80% of the population lived in rural Ethiopia, 26% of the rural residents lived on less than \$1 per day, and 77% of rural women needed to travel more than 20 km to get to a hospital [20].

### Setting

The Wonago district (zone) is located 420 km far away from the capital, Addis Ababa. It has 15 rural and four urban kebeles. A kebele is part of a district (wereda), which is the lowest administrative unit in Ethiopia and comprises approximately 1000–1500 households (an average of 5000–7500 people) [21]. In 2017, the total population of the district was estimated to be 145,000 people [22]. The major ethnic group was the Gedeo people, and the population density was 980 persons per km<sup>2</sup>. Agriculture is the dominant means of livelihood. The district has six health centres, 20 health posts, and two private clinics.

Three kebeles (i.e., Hase-Haro, Mekonisa, and Tumata-Chiricha) were randomly selected by the lottery method from Wonago district, which is located in the Gedeo zone in southern Ethiopia. The recruitment of pregnant women started in May 2017 and follow-up ended in July 2018. The three kebeles were similar in socio-demographic and economic features to most rural areas in Ethiopia. Mekonisa kebele has one health centre and two health posts, Tumata-Chiricha kebele has one health post, and Hase-Haro kebele has one health centre and one health post. In 2017, the estimated total population of the three kebeles was 29,780 people [22], and the crude birth rate of rural people in Ethiopia was 33.2 per 1000 population [19]. The proportion of observed (number of pregnant women included in our study) to expected (total number of pregnant women) antenatal care visits was 80.3% from the three kebeles, and varied from 70.6% to 85.2%. There is no significant difference between the expected and actual births from the three kebeles,  $\chi^2 = 4.8618(2)$ ,  $p$ -value = 0.09 (Table 1).

### Participants

Pregnant women attending ANC at health posts formed the study population. All women in the reproductive age group in the selected kebeles were the source population. The pregnant women were recruited based on ANC visits mostly in the second trimester, which is estimated to be within 24–28 weeks of gestation according to EDHS 2016 [19]. All women were followed at regular intervals (every two weeks) at home based on a scheduled visit. The inclusion criteria were a pregnant woman who had attended two or more antenatal care visits to a health post. Exclusion criteria were a woman not living in the study area, or not found at home at the scheduled visit. Unfortunately, we did not include women with less than two antenatal visits, and this may have caused a selection bias, as we have discussed.

### Variables

**Outcome variables.** The criteria for identifying illnesses among pregnant women were decided prior to initiating the study. The concepts of illness have been previously used to indicate personal ailments (subjective undesirable state of health) [23]. A pregnant woman with an illness was identified using the illness category and/or by the recording of an associated disability (S1 Table). Illness identification criteria were based on general symptoms and screening of anaemia and hypertension. The symptoms and subsequent use of health services were recorded. Our assumption was that pregnant women would seek healthcare primarily due to medical problems. The primary outcome variable was the incidence of illnesses among

Table 1. Expected and actual pregnancies from each kebele.

Kebele	Total Population	Expected births <sup>a</sup>	Actual births sampled for the study	Births included in the final analysis	% of births included in the study to expected births	X <sup>2</sup> test and p-value
Hase-Haro	9733	323	251	228	70.6	X <sup>2</sup> = 4.8618, p-value = .09
Mokonissa	13746	456	441	388	85.1	
Turnata	6301	209	204	178	85.2	
Chiricha						
Total	29780	989	896	794	80.3	

<sup>a</sup> The number of expected pregnancy calculated based on EDHS 2016 [19]

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pregnant women and measured among all participants. Subsequent use of health services was measured among those who had an illness during pregnancy.

**Exposure variables.** Pregnant women were followed over time to assess the occurrence of illnesses among pregnant women and subsequent use of health services. Women's basic characteristics were defined as women's age, women's age at first marriage and at first birth (increase vs. decrease), marital status (ever married vs. not married), educational status (had formal education vs. had no formal education), occupation (others (daily labourer, farming, etc.) vs. domestic service), wealth index (rich vs. poor), total monthly household expenditure (\$30+ vs. <\$30), gravidity (multigravida vs. primigravida), parity (multipara vs. nullipara) prior viable pregnancy, birth interval (2+ years vs. <2 years), and history of abortion (yes vs. no) and stillbirth (yes vs. no). Community or kebele level exposure status of the pregnant women was defined as the type of road to the nearest health facility (asphalt vs. others), and walking distance to the nearest health post (30+ minutes vs. <30 minutes).

### Measurements

Questionnaires were used to assess illnesses among pregnant women and the use of health services. Blood pressure was measured by the Riester ri-champion<sup>®</sup> N digital apparatus ([www.riester.de](http://www.riester.de)), and haemoglobin (Hgb) was measured by the HemoCue analyzer<sup>®</sup> Hb 301 System ([www.hemocue.com](http://www.hemocue.com)).

Hgb values for pregnant women were categorized into no anaemia (> = 11 g/dl), mild anaemia (10–10.9 g/dl), moderate anaemia (7–9.9 g/dl), severe anaemia (4–6.9 g/dl), and very severe anaemia (< = 3.9 g/dl). As the concentration of Hgb declines during the first trimester, reaches its lowest point in the second trimester, and begins to rise again in the third trimester, due to physiological changes, Hgb values for pregnant women were determined at around the third trimester, or 27 gestational weeks or later [24].

Hypertension during pregnancy was classified as either a systolic blood pressure greater than 140 mmHg, or diastolic blood pressure greater than 90 mmHg, or both [25]. At the time of each visit, blood pressure (BP) readings were taken in at least one-minute intervals [26] between two consecutive readings, and their mean was recorded.

### Sample size

The sample size was determined by Openepi software Version 3.03 ([www.openepi.com](http://www.openepi.com)). To obtain the maximum sample size, we used different socio-demographic factors as exposure variables and the incidence of illnesses among pregnant women as outcome variables. The following assumptions were made to assess the sample size: 15.5% of the incidence of illnesses among pregnant women, and 1.65 relative risk [7] among poor compared with rich women,

with 95% confidence level, 80% power, and 1:1 ratio of unexposed to exposed. The sample size was estimated to be 898 after adding 10% for non-response (Fig 1).

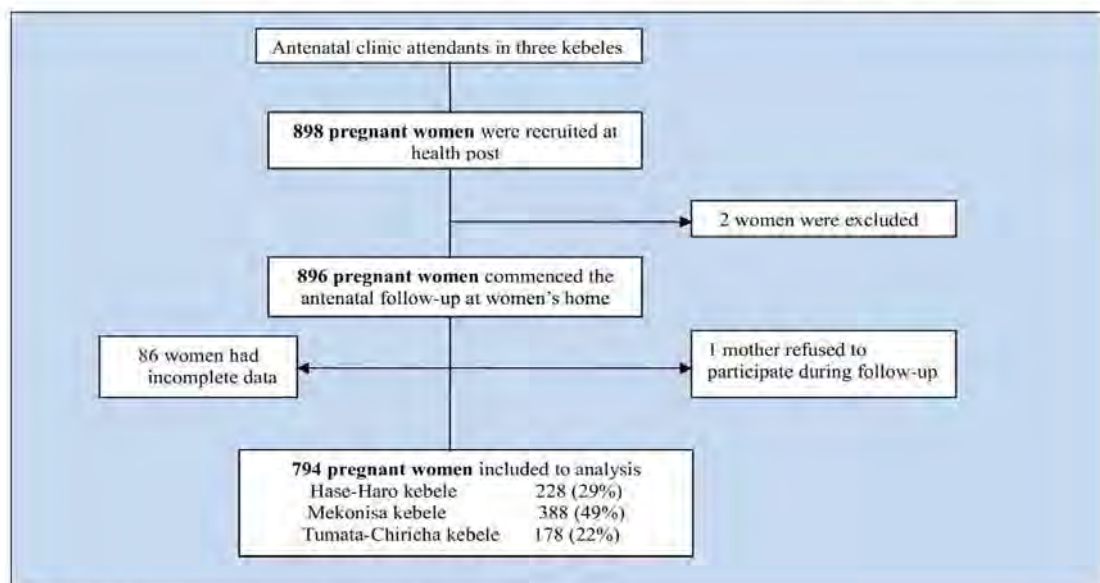
### Quantitative variables

Continuous variables were assessed for symmetry, and parametric tests were used for normally distributed variables. For example, women's age was categorised into the following groups (15–19, 20–24, 25–29, 30–34, and 35+ years), women's age at first marriage (10–14, 15–19, 20–24, and 25–29), and women's age at first birth (15–19, 20–24, and 25–29). Walking distance to the nearest health post was classified based on the mean of the sample in minutes (<30 and 30+), and household total daily expenditure categorized based on the \$1 a day poverty line for developing countries [27] (<\$30 and \$30+ a month).

### Data collection

At baseline and during the follow-up period, we collected information on variables that are important for the study. We then assessed illness among pregnant women. The illnesses during pregnancy may occur once or multiple times. The follow-up time ranged from four weeks to 14 weeks. The data were collected at home every two weeks, and only one woman per household was included in the study. At each visit, data on the use of health services and reasons why they did not seek healthcare were collected from the women.

Data were collected using a validated interviewer-administered questionnaire, which was adapted from the "WHO maternal morbidity measurement tool pilot: study protocol" [2] by



**Fig 1. Flowchart of recruitment of pregnant women in rural southern Ethiopia, 2017/18.**

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piloting the questionnaire. The pregnancy questionnaires were prepared in English, translated into the local languages, i.e., Gedeo language (S1 Questionnaire.rar) and Amharic (S2 Questionnaire.rar), and then back-translated into English (S3 Questionnaire.rar). A pre-test was conducted in a neighbouring kebele. The data collectors read the symptoms, and women indicated whether they had any of the symptoms before the current visit (in the past two weeks). Pregnant women were also asked to report any other health-related problems that they had experienced. The six data collectors were women, residents of the selected kebeles, and had completed grade 10.

### Operational definitions

**Stillbirth:** a baby born with no signs of life at or after 28 weeks' gestation [28]. **Abortion:** is the natural death of an embryo or fetus before it is able to survive independently before 28 weeks of gestation. **Gravidity:** all number of pregnancies in a lifetime (includes complete or incomplete). **Parity:** number of children previously borne by a woman (excludes abortions, but it includes stillbirths). **Utilisation of health services:** defined as the number of healthcare services used by persons for the purpose of curing illnesses. **Recurrent events:** an event (i.e., illness and use of health services) experienced repeatedly by pregnant women. These events could all be of the same type or different types. **Repeated measures:** a research design that involves multiple measures of the same variable taken on the same subjects either under different conditions or over two or more time periods. Therefore, in this study, we measured repeatedly the type of illnesses and use of health services during pregnancy. **Multiple responses:** refers to the situation in which people are allowed to tick or respond with more than one answer option for a question.

### Statistical methods

The data were entered in EpiData version 3.1 software (EpiData Association Odense, Denmark). Principal components analysis (PCA) was utilized to construct a wealth index of households based on 35 household assets and facilities. For this study we used two categories of quintiles (i.e. from 1st to 3rd quintiles categorized as poor, and the 4<sup>th</sup> and 5<sup>th</sup> quintiles categorized as rich). Descriptive statistical analysis was used to determine the distribution of the incidence of illnesses and the use of health services.

In this recurrent events analysis, the pregnant woman was at risk for the same or different events throughout the follow-up period, regardless of whether or not an event has occurred. Different pregnant women, of course, could have different numbers of events; some women had no illness or did not use health services, whereas others had many or did use health services. However, these different numbers of events that were observed across different pregnant women tended to follow a certain pattern that can be described using a Poisson distribution [29]. The recurrent event was described by estimating the mean cumulative function, which was the average number of cumulative events experienced by a pregnant woman in the study since the start of follow-up. The outcome (an event) was analysed as a count variable, and illnesses as exposure for use of health services were also analysed.

In this paper, two classes of statistical models were used to analyze recurrent event data: Poisson regression model and longitudinal techniques, which are an extension of the Cox-proportional hazards regression survival model. Cumulative number of events (counts) and event rates (total number of events divided by total follow-up period) by the end of the study were assessed using these two models.

Poisson regression is a technique that models the number of events (i.e., illnesses and use of health services) and the length of follow-up time. In the Poisson analysis method, all events

were assumed to be independent. The Poisson model does not utilize all available data, but rather uses only one summary observation for each pregnant woman. The Poisson analysis method was done for the count data, including an offset for the time in the study, and event rates. Poisson logistic regression analysis was performed to analyse the difference in the proportion of pregnant women with illnesses at the end of the study. The data structure for fitting the Poisson regression model was composed of a column labelled "number of events" which was used as an outcome, and a column labelled "the length of follow-up time" which was used as an offset term. To account for the different lengths of follow-up between pregnant women, we included an offset term denoting the length of follow-up. In the dataset, each pregnant woman contributed one record.

In longitudinal techniques, the model does not use one observation for each pregnant woman, but instead all observations for each pregnant woman are used in the analysis. In such a long data structure, there was more than one record present for each pregnant woman. The time at risk is defined as the total time approach, in which the starting point for each period is the beginning of the study. The Prentice-Williams-Peterson (PWP) total time model is an extension of the Cox-proportional hazards regression survival model, which was utilized to analyze the repeated occurrence of events (recurrent events) over time, as there is a dependency of observations within a pregnant woman [30]. The PWP total time model considers each sequential event (first, second, etc.) separately because the time scale used in this model is the time from study entry. The model was stratified by event sequence, so that the baseline hazard function can differ between the sequential events. The PWP total time model allows any covariate to have different associations with different sequential events. The data structure for fitting the PWP total time model was composed of a column labelled "sequence number" which represents the order of time intervals for each pregnant woman which is unique to each sequential event and can be used to define the strata, the columns labelled "start-time" and "end-time" represents the start and end time of each interval, respectively, and the column "event indicator" represents whether an event occurs at the end of the time interval.

A multivariable regression model was carried out to identify independent predictors of the incidence of illnesses. The interaction effect of 20 exposure variables was examined, and no significant interaction effects were observed. The Hosmer and Lemeshow recommendations were used in the selection of the factors, which were  $P$ -values  $\leq 0.2$  in univariate analysis for multivariate analysis [31].  $P$ -values  $\leq 0.05$  were used as cut-off points to determine statistical significance. Poisson regression and the PWP total time model survival model was fitted in STATA software version 15 (Stata Corp., LLC. College Station, Texas U.S.A.).

### Ethical considerations

This study was approved by the Institutional Ethical Review Board at Hawassa University, College of Medicine and Health Sciences (IRB/100/08), and by the Regional Committees for Medical and Health Research Ethics (REC) of western Norway (2016/1626/REK vest). Written permission letters remain from the Gedeo Zone Health Department and the Wonago Wereda (district) health office. Written informed consent was obtained from each mother after she had received an explanation of the purpose of the study. The privacy, anonymity, and confidentiality of study participants were maintained. If a woman was found to have an illness during pregnancy, the data collectors linked the patient with health extension workers in the kebele.

## Results

The response rate was 88.6% (794 of 896 women), and 11.4% (102 of 896 women) had incomplete data (86 women had defaulted, one died, one refused to participate, and 14 abortions occurred after week 21 and before 28 weeks of gestation) (Fig 1).

### Background characteristics of the pregnant women

Table 2 presents the background characteristics of the pregnant women. Almost all (99.6%; 791 of 794 women) were married, 63.7% (506 of 794 women) were illiterate, and 61.2% (486 of 794 women) were poor. The mean age was 25.3 years (range: 16, 45). The median walking distance to the nearest health post was 30 minutes (interquartile range, IQR: 20, 50). The median monthly household total expenditure was 42.4 USD (IQR: 30.3, 60.1), of which 87% was spent on food.

The mean age of pregnant women at their first marriage was 18.1 years (range: 14, 28), and the mean age at first birth was 19.4 years (range: 16, 28). Approximately one-quarter (23.3%; 185 of 794 women) reported that the current pregnancy was their first pregnancy, and 54.3% (431 of 794 women) had two or more children.

### Birth outcomes

Approximately two-thirds (64.1%; 509 of 794 women) delivered at home, and of these, 96.3% (490 of 509 women) were attended by family members. There were 781 singleton and 13 multiple births. Vaginal deliveries accounted for 98.6% (783 of 794 women) of the deliveries. Fourteen women experienced abortions before 28 weeks of gestation (17.6 per 1000 pregnant women), and 26 deliveries resulted in a stillbirth (stillbirth rate 33.2 per 1000 births). We registered one maternal death. None of the women who experienced abortion used health services.

### Incidence of illnesses among pregnant women

Table 3 shows illnesses among pregnant women, the use of health services, and reasons for not using health services. Over an average follow-up of 9.9 weeks, there was a total of 6,705 illness episodes (minimum = 1, maximum = 45, and median = 6 episodes per pregnant woman). The total length of follow-up time for each of the types of illnesses was 7852 pregnant women-weeks. The incidence rate of episodes of illnesses was 92.6 per 100 pregnant-woman-weeks (95%CI: 90.6%, 94.2%) (5145 failures in multiple-failure-per-subject data over 5558 total analysis time at risk and under observation). Approximately 735 of 794 pregnant women experienced at least one type of illness during pregnancy with an average of eight episodes of illnesses per woman. During pregnancy, tiredness (72.4%), heartburn (62.5%), pain in the pelvic area (52.6%), severe headache (46.5%), and dizziness (42.9%) constituted the most common problems facing the women during pregnancy (Table 3).

Illnesses that we regarded as severe during pregnancy and needed to be examined by health workers (i.e. severe headache, severe vomiting and nausea, hypertension, anaemia, blurred vision with headache, fever, oedema of leg, severe abdominal pain, vaginal discharge or itching, vaginal bleeding, and oedema of face and hand) accounted for 21.3% (1430 of 6705 episodes of illnesses).

### Anaemia

Of 794 pregnant women, 22.3% (95%CI: 20%, 25%) were anaemic, of which 13.9% (110) was mild, 7.9% (63) moderate, and 0.5% (4) severe. However, 93.5% (95%CI: 92%, 95%) (742/794) of pregnant women did not get iron-folic-acid tablet supplementation. Although 177 of 794

Table 2. Characteristics of the antenatal care study population in Wonago district, rural southern Ethiopia, May 2017 to July 2018 (= 794).

Socioeconomic characteristics		Frequency	Percent
Kebele/residence	Mekonisa	388	48.9
	Hase-Haro	228	28.7
	Tumata-Chiricha	178	22.4
Age of mother in years	15–19	106	13.4
	20–24	226	28.5
	25–29	289	36.4
	30–34	131	16.5
	35+	42	5.3
Marital status	Not married	3	0.4
	Ever married	791	99.6
Maternal educational status	Had no formal education	506	63.7
	Had formal education	288	36.3
Maternal occupation	Domestic service	734	92.4
	Others (daily labourer, farming, etc.)	60	7.6
Wealth index	Poor	333	41.9
	Rich	461	58.1
Type of road to the nearest health facility	Others	586	73.8
	Asphalt	208	26.2
Walking distance to the nearest health post in minutes	<30	437	55.0
	30+	357	45.0
Walking distance to the nearest health centre in minutes	<40	522	65.7
	40+	272	34.3
Walking distance to the nearest hospital in minutes	<60	335	42.2
	60+	459	57.8
Total household total expenditure per month	<\$30	197	24.8
	\$30+	597	75.2
<b>Demographic characteristics</b>			
Age of mother at first marriage in years	10–14	1	0.1
	15–19	714	89.9
	20–24	78	9.8
	25–29	1	0.1
Age of mother at first birth in years	15–19	451	56.8
	20–24	337	42.4
	25–29	6	0.8
Gravidity (no. of pregnancy)	Primigravida	185	23.3
	Multigravida	609	76.7
Parity (no. of birth)	Nullipara	187	23.6
	Multipara	607	76.4
Birth interval in years	<2	387	48.7
	2+	407	51.3
History of abortion	No	746	94.0
	Yes	48	6.0
History of stillbirth	No	756	95.2
	Yes	38	4.8

1 USD = 27.64 ETB on August 31, 2018.

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Table 3. Illnesses among pregnant women, use of health services, and reasons for not using health services in rural southern Ethiopia, May 2017 to July 2018.

Types of illnesses	No. of women with illness	%	No. of women without illness	No. of events for illnesses (episodes of illness)	Length of follow-up time	No. of events for the use of health services (episodes of the use of health services)		Episodes of illness per woman N(95%CI)*	Reason for not using the health services at least once								Total
						Yes	%		Waited for self-recovery		The illness was not serious		Lack of money		Lack of trust		
									Yes	%	Yes	%	Yes	%	Yes	%	
Tiredness	575	72.4	219	1277	7852	100	7.8	2.2(1.8,2.6)	253	13.4	214	14.6	93	10.9	13	9.4	573
Heartburn	496	62.5	298	1097	7852	59	5.4	2.2(1.8,2.6)	205	10.9	208	14.2	76	8.9	12	8.7	501
Pain in the pelvic area	418	52.6	376	742	7852	62	8.4	1.9(1.5,2.3)	214	11.4	152	10.4	68	8.0	10	7.2	444
Severe headache	369	46.5	425	594	7852	62	10.4	1.7(1.3,2.0)	183	9.7	117	8.0	80	9.4	10	7.2	390
Dizziness	341	42.9	453	594	7852	48	8.1	1.7(1.3,2.1)	133	7.1	83	5.7	76	8.9	11	8.0	303
Cramp	292	36.8	502	419	7852	42	10.0	1.4(1.1,1.7)	134	7.1	93	6.4	63	7.4	8	5.8	298
Loss of appetite	238	30.0	556	335	7852	23	6.9	1.4(1.1,1.7)	105	5.6	83	5.7	49	5.7	9	6.5	246
Abdominal distension	227	28.6	567	332	7852	25	7.5	1.5(1.2,1.8)	123	6.5	98	6.7	65	7.6	11	8.0	297
Severe nausea and vomiting	197	24.8	597	252	7852	15	6.0	1.3(1.0,1.6)	106	5.6	84	5.7	50	5.8	5	3.6	245
Anaemia	177	22.3	617	177	7852	14	7.9	1	59	3.1	57	3.9	22	2.6	6	4.3	144
Lack of sleep	135	17.0	659	180	7852	19	10.6	1.3(1.0,1.6)	71	3.8	48	3.3	35	4.1	4	2.9	158
Blurred vision with a headache	107	13.5	687	143	7852	25	17.5	1.3(1.0,1.6)	47	2.5	33	2.3	39	4.6	8	5.8	127
Fever	105	13.2	689	139	7852	10	7.2	1.3(1.0,1.6)	64	3.4	52	3.6	30	3.5	4	2.9	150
Backache	85	10.7	709	105	7852	13	12.4	1.2(0.9,1.5)	34	1.8	27	1.8	34	4.0	8	5.8	103
Dysuria	80	10.1	714	91	7852	5	5.5	1.1(0.8,1.4)	36	1.9	21	1.4	16	1.9	4	2.9	77
Shortness of breath	37	4.7	757	42	7852	6	14.3	1.1(0.8,1.4)	19	1.0	7	0.5	16	1.9	3	2.2	45
Stillbirth	26	3.3	768	26	7852	3	11.5	1	8	0.4	10	0.7	2	0.2	0	0.0	20
Oedema of legs	25	3.1	769	63	7852	10	15.9	2.5(2.1,2.9)	17	0.9	14	1.0	6	0.7	1	0.7	38
Hypertension (> = 140/90mmHg)	21	2.6	773	21	7852	1	4.8	1.8(1.4,2.2)	37	2.0	45	3.1	10	1.2	2	1.4	94
Severe abdominal pain	17	2.1	777	17	7852	3	17.6	1.0(0.7,1.3)	8	0.4	4	0.3	8	0.9	4	2.9	24
Abortion	14	1.8	780	14	7852	0	0.0	1	6	0.3	2	0.1	1	0.1	0	0.0	9
Varicose vein	12	1.5	782	21	7852	1	4.8	1.8(1.4,2.2)	8	0.4	5	0.3	4	0.5	1	0.7	18
Vaginal discharge or itching	10	1.3	784	12	7852	5	41.7	1.2(0.9,1.5)	7	0.4	3	0.2	5	0.6	2	1.4	17
Vaginal bleeding	6	0.8	788	6	7852	1	16.7	1.0(0.7,1.3)	3	0.2	2	0.1	6	0.7	1	0.7	12
Oedema of face and hands	6	0.8	788	6	7852	1	16.7	1.0(0.7,1.3)	2	0.1	2	0.1	1	0.1	1	0.7	6

(Continued)

Table 3. (Continued)

Types of illnesses	No. of women with illness	%	No. of women without illness	No. of events for illnesses (episodes of illness)	Length of follow-up time	No. of events for the use of health services (episodes of the use of health services)	Episodes of illness per woman	Reason for not using the health services at least once									
								Waited for self-recovery		The illness was not serious		Lack of money		Lack of trust		Total	
								Yes	%	Yes	%	Yes	%	Yes	%		
<b>Total</b>	<b>4016<sup>1</sup></b>	<b>92.6<sup>2</sup></b>		<b>6705<sup>3</sup></b>		<b>553<sup>4</sup></b>	<b>8.3</b>	<b>1.7(1.3,2.1)<sup>6</sup></b>	<b>1882</b>	<b>43.4<sup>7</sup></b>	<b>1464</b>	<b>33.7</b>	<b>855</b>	<b>19.7</b>	<b>138</b>	<b>3.2</b>	<b>4339</b>

<sup>1</sup>Number of episodes of illnesses divided by number of women with illness per row;

<sup>2</sup>Total number of women with illness;

<sup>3</sup>Total number of women with illness divided by total number of women in the study;

<sup>4</sup>Total episodes of illnesses;

<sup>5</sup>Total episodes of use of health services;

<sup>6</sup>Total episodes of use of health services (553) divided by total episodes of illnesses (6705);

<sup>7</sup>Total episodes of illnesses divided by total number of women with illness;

<sup>8</sup>Total number of reasons in each column divided by overall number of reasons (e.g., 1882/4339 for waited for self recovery).

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pregnant women were anaemic, the uptake of iron-folic-acid tablet supplementation was only 6% (48 of 794 women).

### Hypertension

The incidence of hypertension was 2.6% (95%CI: 1.7%, 4.0%) (21 of 794 pregnant women); however, the rate of use of health services was only 4.8% (1 of 21 women).

### Determinants of illnesses among pregnant women

Table 4 presents the results of Poisson regression and Prentice-Williams-Peterson (PWP) total time survival analysis of illnesses among pregnant women. In the Poisson analysis, gravidity, history of abortion, and walking distance to access the nearest hospital were statistically significant. In the Cox analysis, history of abortion and walking distance to access the nearest hospital were statistically significant.

The probability of illnesses among the women who have been pregnant two or more times was 42% higher compared to the women who have been pregnant for the first time (ARR = 1.42; 95%CI = 1.02, 1.96). Those pregnant women who had a history of stillbirth were 30% more likely to have an illness compared to those pregnant women who had no history of stillbirth (ARR = 1.30; 95%CI = 1.03, 1.64). Those pregnant women who walked more than 60 minutes to access the nearest hospital were 39% more likely to have an illness compared to those who walked less than that (ARR = 1.39; 95%CI = 1.17, 1.64).

Regarding the hazard ratios for recurrent events (illnesses), during the follow-up period, the total time approach showed that the risk of illness was 6% higher among pregnant women with a history of abortion than those who had no history of abortion; adjusted hazard ratio (AHR = 1.06; 95%CI = 1.02, 1.11). Furthermore, the risk of illness was also 8% higher among pregnant women who walked more than 60 minutes to access the nearest hospital than those who walked less than that (AHR = 1.08; 95%CI = 1.03, 1.14).

Table 4. Poisson regression and Prentice-Williams-Peterson (PWP) total time survival analysis of illnesses among pregnant women in rural southern Ethiopia, May 2017–July 2018.

Exposure variables	Poisson regression analysis					Prentice-Williams-Peterson (PWP) total time survival analysis					
	Total no. of events for illnesses (n = 6705)	CRR (95.0% CI)	p-value	ARR (95.0% CI)	p-value	Status of total events (illness as Yes/No) (n = 5558 person-time)		CHR (95.0% CI)	p-value	AHR (95.0% CI)	p-value
						Yes	No				
Women's age in years	6705	1.02 (1.01, 1.03)	0.001	-	-	5145	413	1.00 (0.99, 1.01)	0.348	-	-
Women's age at first marriage in years	6705	0.97 (0.92, 1.03)	0.304	-	-	5145	413	0.99 (0.97, 1.01)	0.174	-	-
Women's age at first birth in years	6705	1.01 (0.96, 1.05)	0.759	-	-	5145	413	0.99 (0.98, 1.02)	0.818	-	-
Birth interval in years											
2+	3526	1.08 (0.96, 1.21)	0.222	-	-	2646	203	1.01 (0.97, 1.05)	0.737	-	-
< 2	3179	1.0		-	-	2499	210	1.0		-	-
Women's occupation											
Other (daily labourer, farming, etc.)	564	1.07 (0.87, 1.32)	0.511	-	-	371	49	0.95 (0.87, 1.05)	0.292	-	-
Domestic service	6141	1.0		-	-	4774	364	1.0		-	-
Household wealth index											
Rich	3818	0.97 (0.86, 1.10)	0.663	-	-	3010	217	1.02 (0.98, 1.06)	0.381	-	-
Poor	2887	1.0		-	-	2135	196	1.0		-	-
Total household monthly expenditure											
≥\$30+	5175	1.09 (0.95, 1.26)	0.204	-	-	3857	322	0.99 (0.95, 1.03)	0.594	-	-
<\$30	1530	1.0		-	-	1288	91	1.0		-	-
Gravidity											
Multigravida	5440	1.30 (1.13, 1.50)	0.000	1.42 (1.02, 1.96)	0.036	3962	301	1.02 (0.97, 1.07)	0.495	-	-
Primigravida	1265	1.0		1.0		1183	112	1.0		-	-
Parity											
Multipara	5403	1.27 (1.10, 1.46)	0.001	-	-	3948	301	1.02 (0.97, 1.07)	0.524	-	-
Nullipara	1302	1.0		-	-	1197	112	1.0		-	-
History of abortion											
Yes	565	1.44 (1.15, 1.81)	0.002	-	-	329	7	1.06 (1.01, 1.11)	0.011	1.06 (1.02, 1.11)	0.010
No	6140	1.0		-	-	4816	406	1.0		1.0	
History of stillbirth											
Yes	399	1.42 (1.15, 1.76)	0.001	1.30 (1.03, 1.64)	0.026	259	7	1.06 (1.00, 1.12)	0.064	-	-
No	6306	1.0		1.0		4886	406	1.0		-	-
Type of road to the nearest health facility											

(Continued)

Table 4. (Continued)

Exposure variables	Poisson regression analysis					Prentice-Williams-Peterson (PWP) total time survival analysis					
	Total no. of events for illnesses (n = 6705)	CRR (95.0% CI)	p-value	ARR (95.0% CI)	p-value	Status of total events (illness as Yes/No) (n = 5558 person-time)		CHR (95.0% CI)	p-value	AHR (95.0% CI)	p-value
						Yes	No				
Asphalt	1580	0.83 (0.72, 0.95)	0.009	-	-	1323	133	0.98 (0.93, 1.02)	0.309	-	-
Others	5125	1.0		-	-	3822	280	1.0		-	-
Walking distance to the nearest health post in minutes											
30+	3347	1.33 (1.18, 1.49)	0.000	-	-	2352	147	1.03 (0.99, 1.07)	0.126	-	-
<30	3358	1.0		-	-	2793	266	1.0		-	-
Walking distance to the nearest health centre in minutes											
40+	2550	1.18 (1.05, 1.34)	0.007	-	-	1813	91	1.04 (1.01, 1.08)	0.024	-	-
<40	4155	1.0		-	-	3332	322	1.0		-	-
Walking distance to the nearest hospital in minutes											
60+	4279	1.43 (1.27, 1.62)	0.000	1.39 (1.17, 1.64)	0.000	3052	161	1.06 (1.02, 1.11)	0.004	1.08 (1.03, 1.14)	0.003
<60	2426	1.0		1.0		2093	252	1.0		1.0	

Significant at P-value < 0.05, CRR = crude relative risk, ARR = adjusted relative risk, CHR = crude hazard ratio, AHR = adjusted hazard ratio.

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### Utilisation of health services

Over an average follow-up of 9.9 weeks, there was a total of 553 episodes of use of health services (minimum = 1, maximum = 3 episodes per pregnant woman). The incidence rate of episodes of the use of health services was 5 per 100 ill pregnant-woman-weeks (95%CI: 4.5, 5.6) (280 failures in multiple-failure-per-subject data over 5558 total analysis time at risk and under observation). Approximately 41 of 794 pregnant women used health services for at least one type of illness during pregnancy.

The overall utilisation of health services for any illness episodes was only 8.3% (95%CI: 7.6%, 8.9%) (553 episodes of use of health services over 6705 episodes of illnesses). For illnesses that we regarded as severe and needed to be examined by health workers (i.e. severe headache, severe vomiting and nausea, hypertension, anaemia, blurred vision with headache, fever, oedema of leg, severe abdominal pain, vaginal discharge or itching, vaginal bleeding, and oedema of face and hand), only 10.3% used health services (147 episodes of the use of health services over 1430 episodes of illnesses). Furthermore, only two of the six pregnant women with vaginal bleeding used health services. The main reasons for not using health services were that the women thought the illness would heal by itself; women thought the illness was not serious, women could not afford to visit the health institutions, or women lacked confidence in the health institutions (Table 3).

Among 3.9% of pregnant women who had oedema (31 of 794 women), only 32.3% used health services (10 of 31 women). Only two of the mothers who had a severe headache and

excessive tiredness or visual disturbance with a severe headache were referred for further treatment. The main reasons for not using health services were that the women thought the illness would heal by itself (43.4%; 1882 of 4339 responses), women thought the illness was not serious (33.7%; 1464 of 4339 responses), women could not afford to visit the health institutions (19.7%; 855 of 4339 responses), or women lacked confidence in the health institutions (3.2%; 138 of 4339 responses) (Table 3).

The rate of the use of health services during anaemia was only 7.9% (14 episodes of the use of health services over 177 episodes of illnesses). The main reasons were that some women could not afford to visit the health institutions (2.6%; 22 of 855 responses), and women lacked confidence in the health institutions (4.3%; 6 of 138 responses) (Table 3).

For the analysis of the association between each of the illnesses and the use of health services, illnesses were used as exposure and use of health services as outcome variables. The overall analysis showed that a significant association existed between illness and use of health services;  $\chi^2 = 11.99$ ,  $df (1)$ ,  $p\text{-value} < 0.001$ . However, analysis of each type of illness and use of health services indicated that heartburn, dysuria, and swelling of face and hand had no significant association.

#### Determinants of utilisation of health services

Table 5 presents the Poisson regression and Prentice-Williams-Peterson (PWP) total time survival analysis of the use of health services. In the Poisson analysis, none of the exposure variables were statistically significant. However, in the Cox analysis, history of abortion and walking distance to access the nearest hospital were significantly associated.

Regarding the hazard ratios for recurrent events (use of health services), during the follow-up period, the total time approach showed that the use of health services was three times higher among pregnant women with a history of abortion than those who had no history of abortion; adjusted hazard ratio (AHR = 2.5; 95%CI = 1.00, 6.01). Furthermore, the use of health services was also 91% higher among pregnant women who walked more than 60 minutes to access the nearest hospital than those who walked less than that (AHR = 1.91; 95%CI = 1.00, 3.63).

#### Discussion

This study demonstrates that over 90% of rural Ethiopian pregnant women experienced at least one symptom or illness during pregnancy. However, few of them received appropriate care. The Risk factors for both illnesses and utilisation of health services included history of prior pregnancy loss, and whether the pregnant mother lived far away from the health institution.

Being pregnant two or more times in life time was also a risk factors illness among pregnant women. Many of these illnesses were regarded as minor by the pregnant women; however, for potentially severe conditions, such as hypertension, anaemia and vaginal bleeding, the rate of health service utilization was low.

In this study, some of the Poisson regression estimates during illness analysis are different from the Cox-type survival model. Poisson regression estimates had also wider confidence interval than the Cox-type survival model. In addition, Poisson regression analysis of utilisation of health services was not statistically significant. Therefore, interpretation of the results was based on the Prentice, Williams, and Peterson (PWP) total time model as this model is a robust option for recurrent events, and caution should be used when using Poisson regression to analyse recurrent data [29]. The potential reasons for these results are discussed below.

In our study, the rate of illnesses among pregnant women was higher than that found in previously conducted studies in Ethiopia [7], India [32], and Pakistan [33]. This discrepancy

Table 5. Poisson regression and Prentice-Williams-Peterson (PWP) total time survival analysis on the use of health services for illnesses among pregnant women in rural southern Ethiopia, May 2017–July 2018.

Exposure variables	Poisson regression analysis					Prentice-Williams-Peterson (PWP) total time survival analysis					
	Total no. of events for the use of health services (n = 553)	CRR (95.0% CI)	p-value	ARR (95.0%CI)	p-value	Status of total events (use of health services as Yes/No) (n = 5558 person-time)		CHR (95.0%CI)	p-value	AHR (95.0%CI)	p-value
						Yes	No				
Women's age in years	553	1.05 (0.98, 1.12)	0.152	-	-	280	5278	1.03 (0.97, 1.09)	0.306	-	-
Women's age at first marriage in years	553	1.27 (0.97, 1.66)	0.082	-	-	280	5278	1.08 (0.83, 1.41)	0.555	-	-
Women's age at first birth in years	553	<b>1.29 (1.08, 1.55)</b>	<b>0.006</b>	-	-	280	5278	1.18 (1.00, 1.39)	0.053	-	-
Birth interval in years											
2+	253	0.86 (0.44, 1.65)	0.640	-	-	119	2730	0.70 (0.38, 1.29)	0.256	-	-
< 2	300	1.0		-	-	161	2548	1.0		-	-
Women's occupation											
Other (daily labourer, farming, etc.)	45	1.05 (0.38, 2.87)	0.928	-	-	28	392	1.36 (0.50, 3.69)	0.547	-	-
Domestic service	508	1.0		-	-	252	4886	1.0		-	-
Household wealth index											
Rich	315	1.05 (0.55, 2.02)	0.884	-	-	161	3066	0.98 (0.53, 1.80)	0.941	-	-
Poor	238	1.0		-	-	119	2212	1.0		-	-
Total household monthly expenditure											
\$30+	490	<b>2.87 (1.13, 7.32)</b>	<b>0.027</b>	-	-	245	3934	2.31 (0.92, 5.82)	0.076	-	-
<\$30	63	1.0		-	-	35	1344	1.0		-	-
Gravidity											
Multigravida	493	1.81 (0.81, 4.07)	0.151	-	-	231	4032	1.43 (0.64, 3.18)	0.378	-	-
Primigravida	60	1.0		-	-	49	1246	1.0		-	-
Parity											
Multipara	485	1.36 (0.61, 3.01)	0.452	-	-	224	4025	1.23 (0.58, 2.63)	0.589	-	-
Nullipara	68	1.0		-	-	56	1253	1.0		-	-
History of abortion											
Yes	95	2.20 (0.85, 5.66)	0.103	-	-	35	301	2.22 (0.91, 5.41)	0.079	<b>2.50 (1.00, 6.01)</b>	<b>0.050</b>
No	458	1.0		-	-	245	4977	1.0		1.0	
History of stillbirth											
Yes	27	0.92 (0.13, 6.35)	0.934	-	-	7	259	0.51 (0.07, 3.62)	0.501	-	-
No	526	1.0		-	-	273	5019	1.0		-	-

(Continued)

Table 5. (Continued)

Exposure variables	Poisson regression analysis					Prentice-Williams-Peterson (PWP) total time survival analysis					
	Total no. of events for the use of health services (n = 553)	CRR (95.0% CI)	p-value	ARR (95.0%CI)	p-value	Status of total events (use of health services as Yes/No) (n = 5558 person-time)		CHR (95.0%CI)	p-value	AHR (95.0%CI)	p-value
						Yes	No				
Type of road to the nearest health facility											
Asphalt	198	2.22 (1.14, 4.31)	0.018	-	-	105	1351	1.69 (0.91, 3.14)	0.097	-	-
Others	355	1.0		-	-	175	3927	1.0		-	-
Walking distance to the nearest health post in minutes											
30+	300	1.06 (0.56, 2.00)	0.867	-	-	147	2352	1.35 (0.74, 2.47)	0.326	-	-
<30	253	1.0		-	-	133	2926	1.0		-	-
Walking distance to the nearest health center in minutes											
40+	205	0.78 (0.39, 1.53)	0.461	-	-	92	1812	0.94 (0.50, 1.78)	0.848	-	-
<40	348	1.0		-	-	188	3466	1.0		-	-
Walking distance to the nearest hospital in minutes											
60+	399	1.34 (0.66, 2.74)	0.417	-	-	196	3017	1.70 (0.88, 3.30)	0.114	1.91 (1.00, 3.63)	0.048
<60	154	1.0		-	-	84	2261	1.0		1.0	

Significant at P-value < 0.05, CRR = crude relative risk, ARR = adjusted relative risk, CHR = crude hazard ratio, AHR = adjusted hazard ratio.

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could be explained by the fact that our study constituted a cohort study with multiple visits to pregnant women's homes, and the other studies were cross-sectional. However, the incidence of illnesses was similar to 90.3% from population-based studies in Sri Lanka [34]. The Sri Lankan study showed that illnesses considered as minor were judged not to be minor for women. However, as shown by our study, the overall rate of the use of health services for illnesses during pregnancy was low. The reasons for not seeking care during illnesses included a lack of money, a longer time to travel to a health facility, and women lived far from health facilities.

A severe form of illness during pregnancy could include bleeding, anaemia, hypertension, and fever [35]. Pregnant women with these symptoms did not receive the necessary care at the health posts and were not referred for treatment. Indeed, our study determined that only 37 out of 582 pregnant women with bleeding, anaemia, hypertension, and fever used health care services. However, a study from Egypt found that all pregnant women with such illnesses used health care services more often [36]. This difference could be ascribed to the socioeconomic status of the women, a lack of trust in the health institutions, financial constraints, and living far away from the health institution. These findings emphasize the critical needs to identify and address barriers to health service utilization, assess the quality of care, re-train health extension workers about illness identification, and take requisite public health measures.

The burden of anaemia in our study was similar to that of other studies in Ethiopia [37,38], and it was most likely resultant from iron deficiency [39]. Our findings revealed that the uptake of iron-folic-acid tablet supplementation and health service utilization for anaemia were low. This low health service utilization during anaemia may put the women at risk, as they were in a severe condition, as documented in our findings. Possible explanations for this could be that poor pregnant woman may prefer to remain at home due to a longer time to travel to health institutions live far away from health institutions are unable to pay for health services and transportation, and have a lack of trust in health institutions.

In this study, pregnant women with the prior history of pregnancy loss [40] and pregnant women who have had many previous pregnancies [41] had an increased incidence of maternal illnesses. Although the incidence of hypertension was high, few hypertensive pregnant women used health services, as has also been reported from Bangladesh [42]. This finding indicated that pregnant women with the prior history of pregnancy loss, pregnant women who have had many previous pregnancies, and pregnant women who had hypertension could be at higher risk of complications of the pregnant women, her child and low utilisation of health services. In addition, only two of the pregnant women with the illness were referred for further treatment. This could be attributed to that pregnant woman with these illnesses were supposed to incur a cost in order to obtain health care services. Although health care services for pregnant women are free, if pregnant women experience any illness, they have to pay for health care and transportation. Therefore, the Ministry of Health should explore how they could cover these costs.

A non-severe form of illness during pregnancy could include dizziness, abdominal cramp, headache, dysuria, shortness of breath, abdominal distension, lack of sleep, pain in the pelvic area and tiredness, and could affect the day-to-day life of pregnant women [34]. In this study, many pregnant women experienced pain in the pelvic area and tiredness, and they did not use health services. This finding was comparable to a study in rural Bangladesh, which reported that although 87% of pregnant women had illnesses during their pregnancy, 73% of them did not seek any care [9]. This finding was also similar to that reported in an Australian longitudinal study, in which many pregnant women had non-severe illnesses, but 68% did not use health services [43], and in Sri Lanka, 90% did not use health services [34]. The use of health services is not primarily determined by a pregnant woman's recognition of a problem. A possible explanation is that pregnant women with illnesses were reluctant to seek, and delayed in seeking, health care as pregnant women with symptoms perceived their illness to be minor and may heal by itself. Further delay in seeking care may result from a lack of trust in the health facilities, as well as underlying household poverty which may preclude the use of health services.

A study in Pakistan suggests that older pregnant women are more likely to have illnesses during the pregnancy period [9], which was consistent with our study. The findings from our study revealed that pregnant women daily labourers and farmers are particularly at risk for illnesses during pregnancy. This finding is similar to that reported in a study in which heavy workloads during pregnancy, including long workdays, are associated with illnesses [44]. Those households with higher annual household expenditures are also at risk of catastrophic payments during illnesses [45]. This is also in accordance with our findings. Therefore, in order to alleviate the problem of the failure to utilize needed health care services, the socio-economic and demographic environment of pregnant women requires additional focus.

The World Health Organization designed a template for how to estimate the incidence of illness during pregnancy based on a cross-sectional study design [2]. However, our results indicate that many illness episodes during pregnancy were not regarded as severe by patients.



Consequently, additional work on how to improve the questionnaires may be needed, and one possibility is to include questions about the use of health services.

Our methods of registration of symptoms, based on a recording of associated disability during pregnancy, revealed a high incidence of illness during pregnancy; however, there was low health care service utilization. A community-based illness survey could be employed for early detection, to improve the health of mothers, and to take necessary public measures. In this regard, this study coincides with the World Health Organisation's matrix for assessing illnesses during pregnancy [2]. The need to measure and count severe or non-severe disabilities reported by pregnant women could assist to address the health needs of pregnant women, and serve as an indicator of access to health care, quality of the health care system, and the possibility of a survey of illnesses to enable more informed decisions.

To the best of our knowledge, this study is the first of its kind in Ethiopia to investigate factors associated with diseases or illnesses during pregnancy and the utilization of health services. It constitutes an antenatal care-based cohort study with repeated measures to identify the determinants of illnesses and subsequent use of health services during pregnancy.

In this study, only those pregnant women who attended antenatal care were recruited, which might constitute a potential selection bias, as a random selection of pregnant women from the communities was not employed. In addition, those pregnant women with less than two antenatal visits were not recruited, and this may have caused a selection bias. However, the proportion of observed (number of pregnant women included in our study) to expected (total number of pregnant women) antenatal care visits in the three kebeles was in agreement with birth registry studies in southwest Ethiopia in which the coverage of maternal health services was approximately 75% [46]. Thus, our study may be representative of pregnant women attending two or more antenatal care visits, but may not be fully representative of pregnant women who had less than two ANC visits or did not attend such services at all. Pregnant women not attending antenatal care could have a higher incidence of illnesses during pregnancy and a lower use of health services. In addition, the recruitment of women was based on ANC attendance and not based on gestational age. As there was a displacement of residents in the study area and its surroundings [47], the number of pregnant women in the analysis was 88.4% due to incomplete data.

## Conclusions

The burden of illnesses during pregnancy is high in rural Ethiopia. Unfortunately, very few ill pregnant women used health care services. Although the Ethiopia Federal Ministry of Health has implemented a health extension programme which has enabled the country to achieve significant improvements in community-based maternal health and healthcare-seeking [48], the findings from this study indicate that much remains to be done, at least in the kebeles. This study provides useful insights concerning illnesses during pregnancy and the use of health services to assist the Ministry of Health to ensure maternal health and strengthen health extension programmes for community-based maternal services to provide a reasonable level of healthcare.

A poor understanding of what severe and non-severe symptoms remain important reasons for the low use of health services. Our study could serve as a basis for more detailed interventions in Ethiopia. Therefore, we recommend that the efforts of the Ministry of Health be directed towards amenable risk factors for immediate clinical and policy interventions on system improvement to increase access and home-based antenatal care services. These intermediate interventions include the promotion of health education in healthcare-seeking that

encourages women to seek appropriate and timely care. In addition, long-term interventions could focus on changing the negative effects of poverty.

As we did not study the health system in the context of illnesses during pregnancy, the content and quality of services provided by health extension workers at the community-level remain unassessed. As the health extension program was developed in a context in which maternal health outcomes and coverage of essential health services were very poor [48], examining the knowledge and skills of health extension workers in identifying and managing illnesses during pregnancy could constitute a productive research area in the future.

### Supporting information

**S1 Table. A table for symptoms of pregnancy-related illnesses and case definition.**  
(DOCX)

**S1 Questionnaire. Pregnancy-related and utilisation of health services questionnaires in Gedeo language.**  
(RAR)

**S2 Questionnaire. Pregnancy-related and utilisation of health services questionnaires in Amharic language.**  
(RAR)

**S3 Questionnaire. Pregnancy-related and utilisation of health services questionnaires in English language.**  
(RAR)

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Appendix I: Questionnaires for Paper I

**Maternal and neonatal illness, health services utilisation, and household out-of-pocket expenditure in rural Ethiopia: A community-based prospective cohort study questionnaire**Code [\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_/\_\_\_\_]  
Household Husband mother neonate**Form 1: Written consent form**

Good morning/afternoon/evening! Hello. My name is \_\_\_\_\_. I am working as data collector for PhD student.

**Protocol Title: Maternal and neonatal illness, health services utilisation, and household out-of-pocket expenditure in rural Ethiopia: A community-based prospective cohort study**

Moges Tadesse Borde (PhD candidate)

**Supervisors:** Bernt Lindtjorn (MD, PhD, professor); University of Bergen, Norway

Eskindir Loha (MSc, PhD); Hawassa University, Ethiopia

Kjell Arne Johansson (PhD, Associate professor); University of Bergen, Norway

**Information sheet to obtain written consent from participants****The purpose of the research:** We are doing a research study on the health of mothers and neonates. This is a PhD dissertation at Hawassa University and the University of Bergen. We are inviting you to participate in this study. The purpose of this study is to know about the problems experienced during pregnancy, at birth, after delivery, where you went for help and to inquire how much you spend on healthcare. The results of this study will be used to improve the antenatal, childbirth, postnatal, and newborn care services. Therefore, we want to know that mothers and newborns have got help for their illnesses.**Why selected?** 1354 pregnant women, a woman who had recently delivered in the 42 days, and neonates in the last 28 days will be asked to take part in this study. A research team will identify and list all women who are pregnant and who gave birth. You have been randomly selected from this list to be part of the study.**What is expected from the respondents?** If you agree to participate in this study, I will now ask you some questions about your household, your experiences of illnesses during pregnancy, at birth, after delivery, about your neonate, and what type of care you had for these illnesses and where you had gone to get help. We will have repeated visit at your home based on our schedule and every visit and/or interview will take about 45 minutes.**Risk and benefits:** There are no risks to you from taking part in the study. But, the study includes some questions to assess postpartum depression. There are some benefits to being a part of this study. For example, you will learn about your feelings toward where to go for help if you have an illness during pregnancy, childbirth, after birth, and for your neonate in the future. You will also benefit by helping to improve the health care in Ethiopia. During the follow up period, in case you or your newborn is ill, based on the severity of illness, the project workers will link you with health extension in the nearest health post, or they will refer you to the nearest health centre or hospital. If needed, the project personnel will assist you or your newborn with such transportation.**Follow-up time:** The pregnant women will be followed until the end the pregnancy (each will be visited every month). During the postnatal period, the recently delivered mother will be followed for 42 days (nine times) at 0, 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup>, 28<sup>th</sup> day, 35<sup>th</sup> and 42<sup>nd</sup> days. At the same time, for neonates, follow-up will be done for 28 days (seven times) at 0, 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup>, and 28<sup>th</sup> days.**Privacy, anonymity and confidentiality:** Your name will be kept confidential. The study forms will be kept for five years in the project office in locked cabinet. Only research staff will be able to see these forms. Mr Moges Tadesse is the Principal Investigators of this research. If you have any questions about this study, you may call Mr Moges at 251-0911923244. If you feel that you have been treated unfair or have been hurt by joining the study you may call Prof Bernt and Dr Eskindir at 251-0912633861 and 251-0913233294 respectively.**Future use of information:** Only anonymous information will be used for this survey and if the information is used in the future after this study, your privacy, anonymity, and confidentiality will be maintained.**Right not to participate and withdraw:** Your participation in this study is voluntary. You have the right to withdraw from the study at any time. Even if you do not want to join the study, or if you withdraw from the study, you will still receive the same quality of medical care at the government health centre.**Compensation:** You will not be paid for your participation in this study. If you agree to our proposal of enrolling you/your neonate in our study, please indicate that by putting your signature or your left thumbprint at the specified space below.

Do you agree to participate? Yes No

\_\_\_\_\_  
Signature or left thumb print of participant\_\_\_\_\_  
Date\_\_\_\_\_  
Signature of the interviewer\_\_\_\_\_  
Date

Thank you for your cooperation.

The signed copies must be 1) to the PI 2) given to participant

NOT VALID WITHOUT THIS STUDY







111.	What is your occupation?	1. Housewife 2. Private work 3. Student 4. Merchant 5. Daily labourer 6. Farmer 7. Government work 99. Others.....																						
112.	How many times have you been pregnant, including this one? (Gravidity)	.....(number)																						
113.	How many times did you give birth? (Parity)	.....(number)																						
114.	How many children do you have now?	.....(number)																						
115.	What is the average age interval between your children?	.....(year)																						
116.	How many of your children died?	.....(number)																						
117.	How many months is this pregnancy?	.....(months)																						
118.	Did you use family planning?	0. No 1. Yes	If no, SKIP to 120																					
119.	If yes in 118, what type of family planning were you using?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>1. Pill</td> <td>0</td> <td>1</td> </tr> <tr> <td>2. Injectable contraceptive</td> <td>0</td> <td>1</td> </tr> <tr> <td>3. Implant</td> <td>0</td> <td>1</td> </tr> <tr> <td>4. Intrauterine contraceptive device (IUCD)</td> <td>0</td> <td>1</td> </tr> <tr> <td>5. Condom</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Others.....</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	1. Pill	0	1	2. Injectable contraceptive	0	1	3. Implant	0	1	4. Intrauterine contraceptive device (IUCD)	0	1	5. Condom	0	1	99. Others.....			
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4. Intrauterine contraceptive device (IUCD)	0	1																						
5. Condom	0	1																						
99. Others.....																								
120.	If no in 118, have you ever had an abortion?	0. No 1. Yes	If no, SKIP to 122																					
121.	How many times?	.....																						
122.	If no in 120, have you ever had a stillbirth?	0. No 1. Yes	If no, SKIP to 124																					
123.	How many?	.....																						
<b>Section 2: ANC History</b>																								
124.	If no in 122, do you have ANC follow-up?	0. No 1. Yes	If no, SKIP to 128																					
125.	How many ANC visits did you have for this pregnancy?	.....(number)																						
126.	Where did you receive ANC follow-up?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>1. Health post</td> <td>0</td> <td>1</td> </tr> <tr> <td>2. Health centre</td> <td>0</td> <td>1</td> </tr> <tr> <td>3. Hospital</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Other.....</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	1. Health post	0	1	2. Health centre	0	1	3. Hospital	0	1	99. Other.....									
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3. Hospital	0	1																						
99. Other.....																								
127.	Whom did you see for ANC?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>1. Health professional (midwife, nurse, Dr)</td> <td>0</td> <td>1</td> </tr> <tr> <td>2. Health extension worker</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Other.....</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	1. Health professional (midwife, nurse, Dr)	0	1	2. Health extension worker	0	1	99. Other.....												
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2. Health extension worker	0	1																						
99. Other.....																								
128.	If no in 124, did you have a Tetanus Toxoid Vaccine (TTV) injection during this pregnancy?	0. No 1. Yes	If no, SKIP to 130																					
129.	How many times did you get this injection?	_____ times																						
130.	If no in 128, What is the source of information for you about ANC use?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>1. Health professional</td> <td>0</td> <td>1</td> </tr> <tr> <td>2. Friends</td> <td>0</td> <td>1</td> </tr> <tr> <td>3. Radio</td> <td>0</td> <td>1</td> </tr> <tr> <td>4. Television</td> <td>0</td> <td>1</td> </tr> <tr> <td>5. Neighbour</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Others.....</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	1. Health professional	0	1	2. Friends	0	1	3. Radio	0	1	4. Television	0	1	5. Neighbour	0	1	99. Others.....			
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2. Friends	0	1																						
3. Radio	0	1																						
4. Television	0	1																						
5. Neighbour	0	1																						
99. Others.....																								

131.	Where do you want to deliver this child?	1. Home 2. Family home 3. Health post 4. Hospital 5. Health centre 6. Private clinic 99. Other.....																			
132.	Whom do you want to help you during delivery?	<table border="0"> <tr> <td></td> <td style="text-align: center;"><u>No</u></td> <td style="text-align: center;"><u>Yes</u></td> </tr> <tr> <td>1. Health professional (midwife, nurse, Dr)</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>2. Traditional birth attendant</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>3. Family (friend)</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>4. Health extension worker</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>99. Other.....</td> <td></td> <td></td> </tr> </table>		<u>No</u>	<u>Yes</u>	1. Health professional (midwife, nurse, Dr)	0	1	2. Traditional birth attendant	0	1	3. Family (friend)	0	1	4. Health extension worker	0	1	99. Other.....			
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2. Traditional birth attendant	0	1																			
3. Family (friend)	0	1																			
4. Health extension worker	0	1																			
99. Other.....																					
133.	Have you been tested for HIV?	0. No 1. Yes	If no, SKIP to 136																		
134.	If your HIV test is positive, are you taking ART drugs?	0. No 1. Yes	If yes, SKIP to 136																		
135.	If not in 134, why?	.....																			
136.	If no in 133 or if yes in 134, during this pregnancy were you given, or did you buy any iron tablets or iron syrup? SHOW TABLETS	0. No 1. Yes	If no, SKIP to 138																		
137.	If you bought it, how much did you pay?	.....birr																			
138.	If no in 136, during this pregnancy were you given, or did you buy any folic acid tablets? SHOW TABLETS	0. No 1. Yes	If no, SKIP to 140																		
139.	If you bought it, how much did you pay?	.....birr																			
140.	If no in 138, were you weighed by health workers?	0. No 1. Yes																			
141.	Was your blood pressure measured?	0. No 1. Yes																			
142.	Were you counselled on nutrition/iodine during pregnancy?	0. No 1. Yes																			
143.	Were you counselled on birth preparedness?	0. No 1. Yes																			
144.	Were you counselled on breastfeeding?	0. No 1. Yes																			
145.	Were you counselled on HIV?	0. No 1. Yes																			
146.	Were you counselled on the care of Low Birth Weight Baby?	0. No 1. Yes																			
147.	Were you counselled on Family Planning?	0. No 1. Yes																			
148.	Were you coached on how to put a baby in KMC position?	0. No 1. Yes																			
149.	Were you counselled on expressing breast milk?	0. No 1. Yes																			
150.	Were you counselled on cup feeding with Breast milk?	0. No 1. Yes																			
151.	Were you counselled on danger signs during pregnancy?	0. No 1. Yes																			

152.	During this pregnancy, did you take any drugs to prevent you from getting malaria?	0.No 1.Yes	If no, SKIP to 154
153.	Which medicines did you take to prevent malaria?	.....	
154.	In no in 152, does your household have any mosquito nets that can be used While sleeping?	0.No 1.Yes	If no, SKIP to 158
155.	How many mosquito nets does your household have?	.....	
156.	Since you got the mosquito net, was it ever soaked or dipped in chemicals to repel mosquitoes or insects?	0.Yes 1.No 2.Not sure	
157.	During this pregnancy, how often did you sleep under the mosquito net?	1.Every night 2.Some nights 3.Never	

Section 3: Pregnancy-related illness questions				
158.	If no in 154, were you sick in the last 2 weeks for the following illnesses?			
			No	Yes
		1. Severe nausea and vomiting	0	1
		2. Backache	0	1
		3. Dizziness	0	1
		4. Heartburn/regurgitation	0	1
		5. Cramps	0	1
		6. Pain in pelvic area	0	1
		7. Headache	0	1
		8. Tiredness	0	1
		9. Dysuria	0	1
		10. Loss of appetite	0	1
		11. Lack of sleep	0	1
		12. Abdominal distension	0	1
		13. Shortness of breath	0	1
		14. Varicose vein	0	1
		15. Swollen legs	0	1
		16. Vaginal discharge/itching	0	1
		17. Severe abdominal pain	0	1
		18. Fever	0	1
		19. Swelling of face and hands	0	1
		20. Vaginal bleeding	0	1
	21. Convulsion			
	22. Visual disturbances/blurred vision			
	With severe headache	0	1	
	99. Others.....			
159.	Were you sick of malaria in the last 2 weeks?	0. No 1. Yes	If no, SKIP to 164	
160.	Would you tell us the duration of the illness?	.....(days)		
161.	Have your blood tested for malaria?	0. No 1. Yes	If no, SKIP to 163	
162.	Was it positive for malaria?	0. No 1. Yes	If yes, go to and check-in health post-registration book	
163.	If no in 161, have taken malaria drug?	0. No 1. Yes		

164.	If no in 159, had you cough in the last 2 weeks?	0. No 1. Yes	If no, SKIP to 170
165.	Would you tell us the duration of the illness?	.....(days)	
166.	Did you have an unusual difficulty of breathing or fast breathing?	0. No 1. Yes	
167.	Did the breathing difficulty or fast breathing from the chest or it include blocking the nose	1. Chest only 2. Nose only 3. Both chest and nose	
168.	Were you examined by a health professional?	0. No 1. Yes	If yes, go to and check-in health post-registration
169.	Have you taken the drug?	0. No 1. Yes	

Section 4: Health service Utilisation																								
170.	If no in 164, did you go to the health facility? For ill only	0. No 1. Yes	If no, SKIP to 178																					
171.	Where did you go?	<table border="1"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>1. Health post</td> <td>0</td> <td>1</td> </tr> <tr> <td>2. Health centre</td> <td>0</td> <td>1</td> </tr> <tr> <td>3. Hospital</td> <td>0</td> <td>1</td> </tr> <tr> <td>4. Private</td> <td>0</td> <td>1</td> </tr> <tr> <td>5. Traditional healer</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Other.....</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	1. Health post	0	1	2. Health centre	0	1	3. Hospital	0	1	4. Private	0	1	5. Traditional healer	0	1	99. Other.....			
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5. Traditional healer	0	1																						
99. Other.....																								
172.	Please, can you tell me the name of the institution?	Name.....																						
173.	Were you registered in the registration book of the institute?	0. No 1. Yes	Please, look the card and compare with registration book																					
174.	How many times did you go?	.....																						
175.	What type of treatment?	.....																						
176.	In how many days?	.....(days)																						
177.	Have you been referred?	1. Not referred 2. Yes to the health centre 3. Yes to hospital																						
178.	If no in 170, If you did not go, what was the reason?	1. Thought that it resolved by itself 2. The illness was not serious 3. Lack of money 4. Lack of confidence in the health facility 5. Health service is not good 99. Others.....																						

Section 5: Diagnosis to be done by our field nurse			
179.	Blood pressure systolic (mmHg)		
180.	Blood pressure diastolic (mmHg)		
181.	Pulse rate		
182.	Haemoglobin (g/dl) (to be done during the first visit or baseline survey)		If done before, SKIP to 183
183.	Body temperature (°C)		
184.	Weight (kg)		
185.	Height (cm)		

Thank you!!

**Form 2: Antenatal illness assessment follow up questionnaire**

Household characteristics	
House ID	[ ___ / ___ / ___ / ___ / ___ ]
Woman ID	2
Kebele/village (Name)	1) Mekonisa    2) Tumata chiricha    3)Hase haro
Sub-kebele	
Date interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview: 1. Completed    2. No pregnant woman at home    3. No all family at home    4. Another appointment 5. Refused	

Section 1: Pregnancy-related illness questions																																																																														
No.	Questions and Filters	Coding Categories	SKIP																																																																											
201.	Were you sick in the last 2 weeks for the following illnesses?	<table border="1"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr><td>1. Severe nausea and vomiting</td><td>0</td><td>1</td></tr> <tr><td>2. Backache</td><td>0</td><td>1</td></tr> <tr><td>3. Dizziness</td><td>0</td><td>1</td></tr> <tr><td>4. Heartburn/regurgitation</td><td>0</td><td>1</td></tr> <tr><td>5. Cramps</td><td>0</td><td>1</td></tr> <tr><td>6. Pain in pelvic area</td><td>0</td><td>1</td></tr> <tr><td>7. Headache</td><td>0</td><td>1</td></tr> <tr><td>8. Tiredness</td><td>0</td><td>1</td></tr> <tr><td>9. Dysuria</td><td>0</td><td>1</td></tr> <tr><td>10. Loss of appetite</td><td>0</td><td>1</td></tr> <tr><td>11. Lack of sleep</td><td>0</td><td>1</td></tr> <tr><td>12. Abdominal distension</td><td>0</td><td>1</td></tr> <tr><td>13. Shortness of breath</td><td>0</td><td>1</td></tr> <tr><td>14. Varicose vein</td><td>0</td><td>1</td></tr> <tr><td>15. Swollen legs</td><td>0</td><td>1</td></tr> <tr><td>16. Vaginal discharge/itching</td><td>0</td><td>1</td></tr> <tr><td>17. Severe abdominal pain</td><td>0</td><td>1</td></tr> <tr><td>18. Fever</td><td>0</td><td>1</td></tr> <tr><td>19. Swelling of face and hands</td><td>0</td><td>1</td></tr> <tr><td>20. Vaginal bleeding</td><td>0</td><td>1</td></tr> <tr><td>21. Convulsion</td><td></td><td></td></tr> <tr><td>22. Visual disturbances/blurred vision</td><td></td><td></td></tr> <tr><td>    With severe headache</td><td>0</td><td>1</td></tr> <tr><td>99. Others.....</td><td></td><td></td></tr> </tbody> </table>		No	Yes	1. Severe nausea and vomiting	0	1	2. Backache	0	1	3. Dizziness	0	1	4. Heartburn/regurgitation	0	1	5. Cramps	0	1	6. Pain in pelvic area	0	1	7. Headache	0	1	8. Tiredness	0	1	9. Dysuria	0	1	10. Loss of appetite	0	1	11. Lack of sleep	0	1	12. Abdominal distension	0	1	13. Shortness of breath	0	1	14. Varicose vein	0	1	15. Swollen legs	0	1	16. Vaginal discharge/itching	0	1	17. Severe abdominal pain	0	1	18. Fever	0	1	19. Swelling of face and hands	0	1	20. Vaginal bleeding	0	1	21. Convulsion			22. Visual disturbances/blurred vision			With severe headache	0	1	99. Others.....			
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202.	Were you sick of malaria in the last 2 weeks?	2. No                      1. Yes	If no, SKIP to 207																																																																											
203.	Would you tell us the duration of the illness?	.....(days)																																																																												
204.	Have your blood tested for malaria?	2. No                      1. Yes	If no, SKIP to 206																																																																											
205.	Was it positive for malaria?	2. No                      1. Yes	If yes, go to and check-in health post-registration book																																																																											
206.	If no in 204, have you taken a malaria drug?	2. No                      1. Yes																																																																												
207.	If no in 202, have you cough in the last 2 weeks?	2. No                      1. Yes	If no, SKIP to 222																																																																											
208.	Would you tell us the duration of the illness?	.....(days)																																																																												
209.	Did you have an unusual difficulty of breathing or fast breathing?	2. No                      1. Yes																																																																												
210.	Did the breathing difficulty or fast breathing from the chest or it include blocking the nose	4. Chest only 5. Nose only 6. Both chest and nose																																																																												
211.	Were you examined by a health professional?	2. No                      1. Yes	If yes, go to and check-in health post-registration																																																																											
212.	Have you taken the drug?	2. No                      1. Yes																																																																												

Section 2: Health service Utilisation				
213.	Did you go for treatment? For ill only	0. No	1. Yes	If no, SKIP to 221
214.	Where did you go?		<u>No</u> <u>Yes</u>	
		4. Health post	0   1	
		5. Health centre	0   1	
		6. Hospital	0   1	
		7. Private	0   1	
		8. Traditional healer	0   1	
		99. Other (mention)		
215.	Please, can you tell me the name of the institution?	Name.....		
216.	Have you been registered in the registration book of the institute?	0. No	1. Yes	Please, look the card and compare with registration book
217.	How many times did you go for treatment?	.....		
218.	What type of treatment did you get?	.....		
219.	In how many days, did you go to a health facility?	.....(days)		
220.	Have you been referred?	1. Not referred 2. Yes to the health centre 3. Yes to hospital		
221.	If no in 213, if you did not go to health institutions, what was the reason?	6. Thinking that it resole by itself 7. The illness was not serious 8. Lack of money 9. Lack of confidence in the health facility 10. Health service is not good 100. Others.....		
Section 3: ANC				
222.	If no in 207, were you given, or did you buy any iron tablets or iron syrup? SHOW TABLETS	0. No	1. Yes	If no, SKIP to 224
223.	If you bought it, how much was it?	.....birr		
224.	If no in 223, were you given, or did you buy any folic acid tablets? SHOW TABLETS	0. No	1. Yes	If no, SKIP to 226
225.	If you bought it, how much was it?	.....birr		
Section 4: Diagnosis to be done by our field nurse				
226.	Blood pressure systolic (mmHg)			
227.	Blood pressure diastolic (mmHg)			
228.	Pulse rate			
229.	Body temperature (°C)			
230.	Bodyweight (kg)			

Thank you!!

## Supplementary information I: for Paper I

Paper I. Table 5.a. Definition of pregnancy-related illness

Type	Definition
Abortion	A pregnancy is ended before 28 weeks of gestation
Stillbirth	A baby born with no signs of life at or after 28 weeks' gestation
High fever	Temperature > 37.5 °C on any day
Foul vaginal discharge/itching	A fluid with burning, rash, and/or odour due to infection of the genital tract
Dysuria	Painful urination
A severe headache	A symptom of pain anywhere in the head
Visual disturbances/blurred vision	A vision disorder with an impairment of the sense of vision
Severe abdominal pain	Stomach ache
A backache	Pain in any region of the back
Vaginal bleeding	Any bleeding through the vagina during pregnancy
Pain in the pelvic area	Pain in the area of the pelvis
Nausea and vomiting	The sensation of unease and discomfort in the upper stomach with an involuntary urge to vomit
Heartburn/regurgitation	Burning sensation in the central chest or upper central abdomen
Cramp	Short-lived pains in your lower abdomen
Lack of sleep	The condition of not having enough sleep
Fatigue/Tiredness	A subjective feeling of tiredness
Loss of appetite	The decreased sensation of appetite
Varicose vein	Veins of the leg that have become enlarged and twisted. Varicose veins are twisted, enlarged veins.
Oedema/Swelling of face and hands	Swollen face and hands
Swelling of legs	Swollen leg, feet, and ankles
Dizziness	Impairment in spatial perception and stability
Abdominal distension	Outward expansion beyond the normal girth of the stomach and waist
Dyspnoea/Shortness of breath	Feeling like one cannot breathe well enough
Anaemia	A pregnant woman was considered anaemic if the Hb concentration was less than 11 g/dl
Hypertension	Either a systolic or a diastolic blood pressure measurement consistently higher than an accepted normal value



Paper II

## PLOS ONE

## RESEARCH ARTICLE

## Incidence of postpartum and neonatal illnesses and utilization of healthcare services in rural communities in southern Ethiopia: A prospective cohort study

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## Abstract

Although improving postpartum and neonatal health is a key element of the Ethiopian health extension program, the burdens of postpartum and neonatal illnesses and healthcare-seeking in rural communities in Ethiopia are poorly characterized. Therefore, we aimed to assess the incidence and risk factors for these illnesses and measure the utilization of healthcare services. We conducted a prospective cohort study of 784 postpartum women and their 772 neonates in three randomly selected *kabeles* in rural southern Ethiopia. Eight home follow-up visits were conducted during the first 42 postpartum days, and six neonate follow-ups were conducted at the same home over the first 28 days of life. The Prentice, Williams, and Peterson's total time Cox-type survival model was used for analysis. We recorded 31 episodes of postpartum illness per 100 women-weeks (95% confidence interval [CI]: 30%, 32%) and 48 episodes of neonatal illness per 100 neonate-weeks (95% CI: 46%, 50%). Anemia occurred in 19% of women (95% CI: 17%, 22%) and low birth weight (<2,500g) in 15% of neonates (95% CI: 13%, 18%). However, only 5% of postpartum women (95% CI: 4%, 7%) and 4% of neonate (95% CI: 3%, 5%) reported utilizing healthcare services. Walking over 60 minutes to access healthcare was a factor of both postpartum illnesses (AHR = 2.61; 95% CI: 1.98, 3.43) and neonatal illnesses (AHR = 2.66; 95% CI: 2.12, 3.35). Birth weight  $\geq$ 2500g was identified factor of neonatal illnesses (AHR = 0.39; 95% CI: 0.33, 0.46). Compared with younger mothers, older mothers with sick newborns (AHR = 1.22; 95% CI: 1.00, 1.50) or postpartum illnesses (AHR = 1.40; 95% CI: 1.03, 1.89) were more likely to seek healthcare. Reasons for not utilizing healthcare services included a belief that the illnesses were not serious or would resolve on their own, little confidence in the healthcare institutions, and the inability to afford the cost. The burden of postpartum and neonatal illnesses in rural communities of southern Ethiopia remains high. Unfortunately, few participants utilized healthcare services. We recommend strengthening the health system that enables identifying, managing, treating, and referring maternal and neonatal illnesses and provide reasonable healthcare at the community level.

## Introduction

Each year, approximately 60 million women worldwide experience pregnancy complications, and up to 20 million experience postpartum illnesses [1]. The postpartum period extends from one hour after delivery of the placenta to 42 days after childbirth (six weeks) [2]. Although 60% of maternal deaths happen during the postpartum period around the world [3], few studies focus on the occurrence and severity of postpartum illnesses in developing countries [4,5]. A small body of emerging literature suggests a high incidence of postpartum illnesses in these countries. For example, in India, about half of all pregnant women experience a postpartum illness [6], and more than 20% experience two or more postpartum illnesses [7]. In Pakistan, about 40% of women experience at least one type of postpartum illness [4]. The most common symptoms of postpartum illnesses are high fever (21%), heavy vaginal bleeding (14%), foul-smelling vaginal discharge (10%) [8], and breast problems (18%) [6]. The prevalence of postpartum anemia ranges from 50% to 80% [9]. Current data on the extent of postpartum hypertension are limited. However, in 2018, a review from Ethiopia indicated that the prevalence of hypertensive disorders during pregnancy is high (6%) [10]. Multiple socioeconomic and demographic factors, such as the cost of healthcare services and poverty, are linked with increased risk of postpartum illnesses [11].

Globally, 2.5 million neonates died in 2017 alone [12]. The neonatal period extends from birth to 28 days after birth (four weeks) [13]. Some studies indicate that one out of every 20 neonates worldwide dies of neonatal illnesses [14]. Most of these illnesses occur immediately after birth. In 2018, a study from Bangladesh indicated that 31% of neonates developed illness, and among those, 67% suffered from fever, 28% from difficult or fast breathing, 28% from low temperature, 13% from poor sucking or feeding, 10% had chest in-drawing, and 37% had more than one of these symptoms [15]. In 2019, 31% of mothers reported neonatal jaundice or low birth weight in their children [16]. Low birth weight <2500g can result from preterm birth (i.e., gestation <37 completed weeks), intrauterine (fetal) growth restriction, or both, and is measured in the first 48 hours of life [17]. Potential factors associated with neonatal illnesses include geographic location; household wealth status; and the mother's marital status, age, education, and occupation [8]. Mothers' and caregivers' perceptions about these illnesses and the cost of treatment can influence their healthcare-seeking behavior [11], which in turn affects neonates' utilization of healthcare services.

In 2003, Ethiopia implemented a health extension program to improve access to and quality of healthcare in rural communities [18]. Yet, identifying and treating postpartum and neonatal illnesses and increasing the use of healthcare services in these populations remain key challenges of the program [19]. Approximately 70% of pregnant women still deliver at home, and healthcare-seeking for ill neonates has remained low. In 2009, illnesses were reported among 26% of neonates in Ethiopia [20]. By 2016, low birth weights still occurred in 13% of children, only 17% of women received care after childbirth, and about 70% of women with postpartum illnesses could not afford healthcare [21]. Therefore, this study aimed to assess the incidence and risk factors for postpartum and neonatal illnesses and measure the utilization of healthcare services in rural communities in southern Ethiopia. The findings might help policymakers address issues related to postpartum and neonatal illnesses and improve the low utilization of healthcare services.

## Materials and methods

A prospective cohort study of 784 women who had recently given birth and their 772 neonates was conducted from May 2017 to July 2018 in three randomly selected *kebeles* (i.e., *Mekonisa*, *Hase-Haro*, and *Tumata-Chiricha*) in the *Wonago* district of southern Ethiopia, which is

located 420 km from the city of Addis Ababa. Each woman was followed up eight times at home during her first 42 postpartum days, and each neonate was followed up six times at the same home over the first 28 days of life. The details of this cohort are described in our previous study about pregnancy-related illnesses [22]. During our study, some women and neonates could not be contacted because of social unrest in a small part of our study area and were therefore excluded.

We defined postpartum illnesses as any disorder after childbirth that hurt a woman's health [23]. Neonatal illnesses were similarly defined as any disturbance of the normal state of the body and organs of the neonate [16]. We defined utilization of healthcare services as any use of healthcare services or any visit to a healthcare facility to get outpatient and inpatient healthcare services to treat postpartum or neonatal illnesses [24]. We defined healthcare services according to the Encyclopedia of Behavioral Medicine as "an array of medical care or services that are recognized under state law and are performed by healthcare professionals or under their direction, for promoting, maintaining, or restoring health to those in need (i.e., patients, families, and communities) in either of all settings of care (i.e., health posts, health centers, hospitals, and homes)" [24].

In Ethiopia, the health service is restructured into a three-tier system: primary, secondary, and tertiary level of healthcare, and the healthcare system is organized based on the type of care provided [25]. In the primary tier system; the primary healthcare unit consists of a health center and five satellite health posts. One health center is for 15,000–25,000 people in rural areas, and 40,000 people in urban areas and each health post is for 3,000–5,000 people in rural areas. The primary hospital serves 60,000–100,000 people. The secondary tier system includes general hospital which is for 1–1.5 million people, and the tertiary tier system also includes a specialized hospital that is for 3.5–5 million people.

The primary tier system embraces all the healthcare services provided at all levels, and at health posts, most primary healthcare services are provided by health extension workers. These lay individuals are not nurses or trained healthcare professionals, although they have received one-year training in primary healthcare. Health extension workers can address issues related to infectious diseases (e.g., tuberculosis, malaria), communicable and sexually transmitted infections (e.g., HIV/AIDS), maternal and child health, common nutritional disorders, hygiene, and environmental health, immunization and family planning, and reproductive health. Most pregnant women in Ethiopia who seek healthcare use their local health posts. If the case is serious, the Health Extension Worker may refer them to a health center [25].

In our study, women with postpartum illnesses were identified based on symptoms and clinical measurements, such as hemoglobin and blood pressure levels [23], recorded by trained data collectors. Hemoglobin was measured at the end of the 6-week postnatal period using the HemoCue analyzer Hb 301 System ([www.hemocue.com](http://www.hemocue.com)). We defined anemia as a hemoglobin value of <12 g/dL at six weeks after childbirth [26]. Blood pressure was measured during each visit using a Riester ri-champion N digital apparatus ([www.riester.de](http://www.riester.de)). High blood pressure was defined as >140/90 mm Hg [27].

Neonates with neonatal illnesses were identified based on reported symptoms by the mother and some measurements, such as neonates' weight and length were measured using the Health O Meter® Portable Home Care Baby Scale (Pelstar, LLC; [www.chichestershomecare.net](http://www.chichestershomecare.net)). Neonatal mortality was defined as the death of the neonate within the first 28 days of life. Low birth weight was defined as <2,500g, measured within the first 48 hours of life. As birth weight is closely associated with neonatal mortality and morbidity and is used as a public health indicator [28], we recorded birth weight as an exposure variable together with other neonatal illnesses [28].

### Outcome variables

We assessed two primary outcomes for mothers and their neonates: illnesses and utilization of healthcare services. We measured these outcomes in two ways: as a count and as a dichotomous value (0 = no, 1 = yes). We assessed 10 symptoms and signs of postpartum illnesses [29,30]: hemorrhage, high fever, foul-smelling vaginal discharge, blurred vision with severe headache, severe abdominal pain, urinary incontinence, breast pain and engorgement, severe tiredness, anemia, and hypertension. S1 Table summarizes the symptoms of postpartum illnesses. We also assessed 12 symptoms and signs of neonatal illnesses [30,31]: not sucking properly, high fever ( $\geq 37.5^{\circ}\text{C}$ ), diarrhea, cord stump with redness or pus, persistent vomiting, hypothermia ( $\leq 35.5^{\circ}\text{C}$ ), fast breathing ( $\geq 60$  breaths per minute), severe chest in-drawing, no spontaneous movement, jaundice, red or discharging eye, and lethargy. S2 Table summarizes the symptoms of neonatal illnesses.

### Exposure variables

The exposure variables for illnesses included participant characteristics and community-level variables. The women's basic characteristics included her age, age at first marriage, age at first birth, birth interval ( $\geq 2$  years or  $< 2$  years between births), occupation (domestic service or other), household wealth index, total monthly household expenditure (more or less than \$30), gravidity, parity, history of abortion, history of stillbirth, marital status, and educational status. The neonates' exposure characteristic was the birth weight ( $\geq 2500\text{g}$  or  $< 2,500\text{g}$ ). Low birth weight  $< 2,500\text{g}$  was regarded as an exposure variable. Community-level variables included the type of road (asphalt or other) and walking distance to the nearest health facility. The exposure variables for the utilization of healthcare services were postpartum and neonatal illnesses and all previously listed exposure variables.

### Quantitative variables

Continuous variables were assessed for symmetry, and parametric tests were used for normally distributed variables.

### Sample size

To assess the sample, we made some assumptions based on our previous study [22]. We assumed a 15.5% incidence of illnesses among pregnant women and a 1.65 relative risk among poor women, compared with rich women (95% confidence level [CI], 80% power, and 1:1 ratio of unexposed to exposed) [32]. The sample size was estimated at 898 after adding 10% for non-responses. S1 Fig summarizes the flowchart of the recruitment of participants.

During the initial recruitment, 898 pregnant women were included in the study. Of those, 86 were excluded due to incomplete data, 14 had abortions, two were not pregnant, and instead had ovarian cysts, one died in an accident, and one refused to participate. Thus, 794 pregnant women were included in the analysis of pregnancy-related illnesses. During the follow-up visits, 10 women with incomplete data were excluded. The final sample thus included 784 postpartum women (S1 Fig).

Neonates born from 794 pregnant women were eligible for inclusion in the study. Out of 808 births, 782 were live births and 26 were stillbirths. Thirteen women had multiple births, and 781 women had singleton births. Of the 782 live births, we excluded 10 due to incomplete data, leaving a final sample of 772 neonates (S1 Fig).

### Data collection

Baseline socioeconomic and demographic data and follow-up data were collected via a questionnaire during visits to participants' homes. Data from postpartum women were collected eight times: within 24 hours and within 24–72 hours after birth and at the end of the first, second, third, fourth, fifth, and sixth weeks. The questionnaire was adapted from the WHO Maternal Morbidity Measurement Tool [33]. Data from neonates were collected six times at the same home visits: within 24 hours and within 24–72 hours of birth and at the end of the 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup>, and 28<sup>th</sup> days. The questionnaire was adapted from the Johns Hopkins University Tools and Indicators for Maternal and Newborn Health [34].

Postpartum and neonatal questionnaires were prepared in English, translated into the local Gedeo (see S1 File Gedeo questionnaire for postpartum women and neonates.rar) and Amharic (see S2 File Amharic questionnaire for postpartum women.rar and S4 File Amharic questionnaire for neonates.rar) languages, and then translated back into the English language (see S3 File English questionnaire for postpartum women.rar and S5 File English questionnaire for neonates.rar).

The trained data collectors read the symptoms aloud and then asked the women to indicate whether they or their neonates had any of the symptoms, whether they utilized healthcare services, and reasons why they did not seek healthcare during illnesses. To assess the need for the utilization of healthcare services during postpartum and neonatal illnesses, a community-based approach was used rather than a facility-based approach [35].

### Statistical methods

The data were entered in EpiData version 3.1 software (EpiData Association, Odense, Denmark). Descriptive statistical analysis was used to determine the distribution of illness incidences and the utilization of healthcare services. In this paper, one statistical model was used to analyze recurrent event data. The interpretation of results and analyses of risk factors were based on Prentice, Williams, and Peterson's total time Cox-type survival model [36,37]. This model is a robust option for recurrent events of illnesses and the utilization of healthcare services. To control for the effect of missing values, the analysis was restricted to women and neonates with complete data [38]. Correlations among variables during pregnancy and postpartum periods or during neonatal and pregnancy periods also were assessed. STATA software version 15 was used for analysis (Stata Corp LLC, College Station, TX, USA). Detailed information on the methods, study design, procedures, sample size, statistical methods, and major findings of illnesses during pregnancy are presented in our previous study [22].

### Ethical considerations

This study was approved by the institutional ethical review board at Hawassa University, College of Medicine and Health Sciences (IRB/100/08), and by the Regional Committees for Medical and Health Research Ethics of Western Norway (2016/1626/REK vest). Written permission was obtained from the *Gedeo* Zone health department and the *Wonago* district health office. Written informed consent was obtained from each woman after she received an explanation of the purpose of the study. The privacy, anonymity, and confidentiality of all participants were maintained. If a data collector observed any illness among participants during the study period, they tried to link the mother or child with health extension workers in the *kebele*.

## Results

### Background characteristics of study participants

A total of 794 postpartum women and their 782 neonates participated in our study. However, 10 women and 10 neonates had incomplete data and were excluded from the study, leaving 784 women and 772 neonates in the analysis. The response rate was 99% (784 of 794 postpartum women and 772 of 782 neonates), as shown in S1 fig. From 794 pregnant women, 13 women had multiple births and 781 women had singleton births, and we registered 808 (782 live and 26 still) births. Among participating neonates, 751 were from singleton births, and 21 were from multiple births.

Table 1 presents the participants' characteristics. Almost two-thirds of the women (509, 64.9%) delivered at home, and 96.3% (490 of 509) of those were attended by family members. Approximately 23.6% (185 of 784) reported that their most recent pregnancy was their first pregnancy. Vaginal deliveries accounted for 98.6% (773 of 784) of deliveries. About 13% (102 of 772) of neonates were born to mothers aged 15–19 years, and 57% (439 of 772) were born to mothers whose age at first birth was younger than 19 years. Nearly 63% (484 of 772) were born to mothers who did not have any formal education. The mean weight of neonates at birth was 2,890g (range: 2000g–4500g).

### Incidence of postpartum illnesses

Table 2 presents the occurrence of postpartum illnesses, utilization of healthcare services, and women's reasons for not utilizing healthcare services. In the six follow-up weeks, 914 illnesses episodes (minimum = 1, maximum = 25) were recorded. The incidence of illnesses was 31 per 100 postpartum women (95% CI: 30.0%, 32.3%) with 1,952 events or illnesses over 6,272 visits (i.e., total analysis time at risk). Among women, 31% (244 of 784) experienced at least one type of postpartum illness. The most common problems reported were anemia, blurred vision with headache, excessive vaginal bleeding, severe abdominal pain, and hypertension. Among all women in the analysis, 3.4% (27 of 784) had foul-smelling vaginal discharge (95% CI: 2.3, 4.9), 2.8% (22 of 784) had breast pain and engorgement (95% CI: 1.8, 4.2), and 0.6% (5 of 784) had high fever (95% CI: 0.2, 1.4). Also, 19% (148 of 784) were anemic (95% CI: 16.4, 21.9), but no iron or folic acid supplementation was administered during the study period. The incidence of hypertension was 3.4% (27 of 784) among the postpartum women (95% CI: 2.3, 4.9).

### Utilization of healthcare services during postpartum illnesses

We recorded 46 episodes of use of healthcare services, or 6.4 uses per 1,000 postpartum women (95% CI: 4.6, 8.6), and 40 events of the utilization of healthcare services over 6,272 visits (i.e., total analysis time at risk). Only 2.0% (5 of 244) of the women who had symptoms of illnesses utilized healthcare services at least once during their illnesses.

The rate of utilization of healthcare service for any episode of illnesses was only 5% (95% CI: 3.8%, 6.6%), or 46 out of 914 illnesses episodes. For symptoms of infection, healthcare services were utilized for foul-smelling vaginal discharge in only 3.9% (2 of 51) episodes. Furthermore, only 6.3% (3 of 48) postpartum women with breast pain and engorgement utilized healthcare services. The main reasons reported by the women for not using healthcare services were that they did not perceive the illnesses as a problem (51.3%; 3,585 of 6,993 responses), they thought the illnesses would resolve on its own (12.6%; 879 of 6,993 responses), they thought the illnesses were not serious (32.9%; 2,298 of 6,993 responses), they could not afford to visit the healthcare institutions (2.9%; 202 of 6,993 responses), and they lacked confidence in the healthcare facilities (0.4%; 29 of 6,993 responses).

## PLOS ONE

## Incidence of postpartum and neonatal illnesses and utilization of healthcare services

Table 1. Characteristics of study participants in rural southern Ethiopia, May 2017 to July 2018.

Socioeconomic characteristics		Postpartum women (n = 784)		Neonates (n = 772)	
		Frequency	Percent	Frequency	Percent
Kebele/residence	Mekontisa	381	48.6	374	48.4
	Hase-Haro	225	28.7	224	29.1
	Tumata-Chiricha	178	22.7	174	22.5
Women's age in years	15–19	103	13.1	102	13.2
	20–24	223	28.4	222	28.8
	25–29	283	36.1	281	36.4
	30–34	134	17.1	125	16.2
	35+	41	5.2	42	5.4
Women' marital status	Ever married	782	99.7	766	99.2
	Not married	2	0.3	6	0.8
Women's educational status	Had formal education	284	36.2	288	37.3
	Had no formal education	500	63.8	484	62.7
Women's occupation	Domestic service	725	92.5	702	90.9
	Others	59	7.5	70	9.1
Household wealth index	Rich	452	57.7	451	58.4
	Poor	332	42.3	321	41.6
Type of road to the nearest health facility	Asphalt	206	26.3	201	26.0
	Others	578	73.7	571	74.0
Walking distance to the nearest health post in minutes	<30	434	55.4	426	55.2
	30+	350	44.6	346	44.8
Walking distance to the nearest health center in minutes	<40	511	65.2	508	65.8
	40+	273	34.8	264	34.2
Walking distance to the nearest hospital in minutes	<60	399	50.9	397	51.4
	60+	385	49.1	375	48.6
Total household total expenditure per month	<\$30	194	24.7	192	24.9
	\$30+	590	75.3	580	75.1
Women's age at first marriage in years	10–14	1	0.1	1	0.1
	15–19	705	89.9	694	89.9
	20–24	77	9.8	76	9.8
	25–29	1	0.1	1	0.1
Women's age at first birth in years	15–19	447	57.0	439	56.9
	20–24	332	42.3	328	42.5
	25–29	5	0.6	5	0.6
Women's gravidity (no of pregnancy)	Multigravida	604	77.0	594	76.9
	Primigravida	180	23.0	178	23.1
Women's parity (no of birth)	Multipara	602	76.8	591	76.6
	Nullipara	182	23.2	181	23.4
Birth interval in years	<2	380	48.5	374	48.4
	2+	404	51.5	398	51.6
Mother's history of abortion	Yes	47	6.0	47	6.1
	No	737	94.0	725	93.9
Mother's history of stillbirth	Yes	36	4.6	36	4.7
	No	748	95.4	736	95.3
Birth type	Singleton	-	-	751	97.3
	Twin	-	-	18	2.3
	Triplet	-	-	3	0.4

(Continued)



## PLOS ONE

## Incidence of postpartum and neonatal illnesses and utilization of healthcare services

Table 1. (Continued)

Socioeconomic characteristics		Postpartum women (n = 784)		Neonates (n = 772)	
		Frequency	Percent	Frequency	Percent
Sex of neonates	Male	-	-	394	51.0
	Female	-	-	378	49.0
Weight of neonates at birth in grams	≥2500	-	-	654	84.7
	<2500	-	-	118	15.3
The length of neonates at birth in cm	<43.0	-	-	445	57.6
	>43.1	-	-	327	42.4

N.B. 1 USD = 27.64 ETB on August 31, 2018; Poor included the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> quintiles, rich included the 4<sup>th</sup> and 5<sup>th</sup> quintiles in the wealth index.

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The rate of utilization of healthcare services for anemia was only 0.7% (1 of 149 episodes). The main reasons for not utilizing healthcare services for anemia were that the women did not perceive anemia as a problem (59.3%; 2,978 of 5,023 responses), they thought anemia would resolve on its own (10.7%; 538 of 5,023 responses), they thought anemia was not a serious health problem (29.2%; 1,467 of 5,023 responses), they could not afford to visit the healthcare institutions (0.7%; 35 of 5,023 responses), or they lacked confidence in the healthcare facilities (0.1%; 5 of 5,023 responses). Although 2.4% of women after childbirth were hypertensive, this problem was not associated with any utilization of healthcare services (Table 2).

### Determinants of postpartum illnesses

Table 3 presents the results of Prentice, Williams, and Peterson's total time Cox-type survival model analysis of postpartum illnesses. Compared to the other women in this study, those who had to walk more than 60 minutes to access the nearest hospital were three times more likely to experience an illness episode during the reporting period (adjusted hazard ratio [AHR] = 2.61; 95% CI: 1.98, 3.43).

### Incidence of neonatal illnesses

Table 4 presents the occurrence of neonatal illnesses, utilization of healthcare services, and the mother's reason for not utilizing healthcare services. In the 28 follow-up days, 1,624 neonatal illness episodes (minimum = 1, maximum = 19) were recorded. The incidence of illnesses was 48 per 100 neonate weeks (95% CI: 45.9%, 49.8%), with 2,214 events or illnesses over 4,632 visits (i.e., total analysis time at risk). There were 14 neonatal deaths (i.e., 19 per 1,000 live births) due to severe chest in-drawing, high fever, low birth weight, fast breathing, or umbilical cord infection, and unknown reasons (accidental).

During the follow-up, the most common problems reported were not sucking well, high fever, diarrhea, and cord stump with redness or pus. Among neonates with severe illnesses, 1.2% (9 of 772) had cord stump with redness or pus (95% CI: 0.6, 2.1), 0.8% (6 of 772) had fast breathing (95% CI: 0.3, 1.6), and 1.4% (11 of 772) had high fever (95% CI: 0.8, 2.5). In addition, 0.4% (3 of 772) had signs of jaundice (95% CI: 0.1, 1.1), and 1.3% (10 of 772) experienced diarrhea (95% CI: 0.7, 2.3). Among those with feeding problems, 35% (272 of 772) were not able to suck well (95% CI: 31.9, 38.7), and 1% (8 of 772) had persistent vomiting (95% CI: 0.5, 2.0).

### Birth weight of neonates

Among neonates, 15% (118 of 772) had low birth weights <2500g (95% CI: 12.9, 18.0). However, only 0.9% (1 of 118) with low birth weight utilized healthcare services. Many mothers did

Table 2. Postpartum illnesses, utilization of healthcare services, and reasons for not utilizing healthcare services in rural southern Ethiopia, May 2017 to July 2018.

Postpartum illnesses	# women with ≥ 1 illness	%	# women without illnesses	# illnesses episodes	# events for the utilization of healthcare services (episodes)		The reasons cited for not utilizing healthcare service at least once												
					Yes	%	No	%	95% CI <sup>1</sup>	Did not perceive the presence of illnesses	Waited for spontaneous recovery	The illness was not serious	Lack of money	Lack of trust	Total				
Anemia	149	19.0	635	349	1	0.27													
Blurred vision with headache	70	16.1	714	299	15	5.0	4.3 (3.6, 5.0)	160	5.0	112	12.9	149	7.4	41	21.3	5	17.2	5023	5023
Excessive vaginal bleeding	62	14.2	722	359	2	1.3	2.6 (2.2, 3.0)	104	2.8	98	11.1	217	9.4	41	20.3	6	20.7	466	466
Severe abdominal pain	38	8.7	746	96	12	12.5	2.5 (2.1, 2.9)	122	3.4	28	3.0	105	4.6	24	11.9	5	17.2	281	281
Pain, swelling, vaginal discharge	27	6.2	757	47	2	3.9	1.9 (1.6, 2.3)	46	1.3	28	3.2	95	4.1	27	13.4	5	17.2	100	100
Urinary incontinence	27	6.2	757	47	2	4.3	1.7 (1.4, 2.0)	38	1.1	47	5.3	88	3.8	20	9.9	3	10.3	196	196
Hypernatremia (>140/90 mm Hg)	27	6.2	757	34	0	0.0	1.3 (0.9, 1.5)	0	0.0	6	0.7	23	1.0	2	1.0	0	0.0	31	31
Breast pain and engorgement	23	5.0	762	48	3	6.3	2.1 (1.8, 2.6)	56	1.6	11	1.3	102	4.4	7	3.5	0	0.0	176	176
Fatigue or tiredness	9	2.1	775	25	9	36.0	2.8 (2.4, 3.2)	41	1.1	7	0.8	17	0.7	2	1.0	0	0.0	87	87
High fever	5	1.1	779	6	0	0.0	1.2 (0.9, 1.5)	20	0.6	5	0.6	14	0.6	1	0.5	0	0.0	40	40
Total	436 <sup>1</sup>	31.1 <sup>2</sup>		914 <sup>3</sup>	46 <sup>4</sup>	5.0 <sup>5</sup>	2.1 (1.8, 2.6) <sup>6</sup>	3585 <sup>7</sup>	31.3	879 <sup>8</sup>	12.6	2298 <sup>9</sup>	32.9	202 <sup>10</sup>	2.9 <sup>11</sup>	29 <sup>12</sup>	0.4	6993 <sup>13</sup>	6993 <sup>13</sup>

<sup>1</sup>Number of episodes of illnesses divided by the number of women with illnesses per row

<sup>2</sup>Total number of women with illnesses

<sup>3</sup>Total number of women with illnesses divided by the total number of women in the study

<sup>4</sup>Total episodes of illnesses

<sup>5</sup>Total episodes of the utilization of healthcare service

<sup>6</sup>Total episodes of the utilization of healthcare service (46) divided by total episodes of illnesses (914)

<sup>7</sup>Total episodes of illnesses divided by the total number of women with illnesses

<sup>8</sup>Total number of reasons in each column divided by the overall number of reasons (e.g., 3585/6993 for waited for spontaneous recovery).

<sup>9</sup><https://doi.org/10.1371/journal.pone.0237852.t002>

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Table 3. Prentice, Williams, and Peterson's total time Cox-type survival model analysis for postpartum illnesses in rural southern Ethiopia, May 2017 to July 2018.

	Status of total events (postpartum illnesses as Yes/No) (n = 6,272 women-weeks)		Crude hazard ratio (95% CI)	p-value	Adjusted hazard ratio (95% CI)	p-value
	Yes	No				
Women's age (years)	1952	4320	1.00 (0.97, 1.02)	0.731	-	-
Women's age at first marriage (years)	1952	4320	1.05 (0.97, 1.34)	0.203	-	-
Women's age at first birth (years)	1952	4320	1.04 (0.97, 1.12)	0.274	-	-
Birth interval (years)						
2+	984	2248	0.96 (0.78, 1.78)	0.673	-	-
<2	968	2072	1.0		-	-
Women's occupation						
Other (daily laborer, farming, etc)	104	368	0.69 (0.42, 1.13)	0.142	-	-
Domestic service	1848	3952	1.0		-	-
Household wealth index						
Rich	1128	2488	1.01 (0.81, 1.24)	0.959	-	-
Poor	824	1832	1.0		-	-
Total household monthly expenditure						
\$30+	1930	4208	1.41 (0.59, 3.37)	0.440	-	-
<\$30	32	112	1.0		-	-
Gravidity						
Multigravida	1480	3352	0.93 (0.73, 1.19)	0.582	-	-
Primigravida	472	968	1.0		-	-
Parity						
Multipara	1464	3352	0.91 (0.72, 1.50)	0.421	-	-
Nullipara	488	968	1.0		-	-
History of abortion						
Yes	96	280	0.81 (0.49, 1.34)	0.412	-	-
No	1856	4040	1.0		-	-
History of stillbirth						
Yes	120	168	1.36 (0.91, 2.03)	0.132	-	-
No	1832	4152	1.0		-	-
Type of road to the nearest health facility						
Asphalt	464	1184	0.88 (0.68, 1.12)	0.292	-	-
Other	1488	3136	1.0		-	-
Walking distance to the nearest health post in minutes						
30+	1008	1792	1.32 (1.08, 1.63)	0.008	-	-
<30	944	2528	1.0		-	-
Walking distance to the nearest health center in minutes						
40+	752	1432	1.17 (0.95, 1.45)	0.140	-	-
<40	1200	2888	1.0		-	-
Walking distance to the nearest hospital in minutes						
60+	1264	1816	1.90 (1.52, 2.38)	0.001	2.61 (1.98, 3.43)	0.001
<60	688	2504	1.0		1.0	

Significant at  $p < 0.05$ ; CI = confidence interval.<https://doi.org/10.1371/journal.pone.0237852.t003>

Table 4. Neonatal illnesses, utilization of healthcare services, and reasons for not utilizing healthcare services in rural southern Ethiopia, May 2017 to July 2018.

Neonatal illnesses	# neonates with >= 1 illnesses			# neonates without illnesses		# illnesses episodes		# events for utilization of healthcare services (episodes)		# illnesses episodes per neonate		The reasons cited for not utilizing the healthcare service at least once				Total	
	Yes	%	N	%	N	%	%	%	Neonate did not have an illness		Waited for spontaneous recovery		The illness was not serious		Lack of money		
									Yes	%	Yes	%	Yes	%	Yes		%
Not suckling well	272	35.2	0	0	500	1,812	8	0.6	119	29.1	6	33.3	17	17.9	1	5.0	145
High fever	8	1.0	3	0.4	761	15	6	40.0	15	4.9	0	0.0	0	0.0	2	10.0	17
Diarrhea	10	1.3	0	0	762	11	100.0	0	0.0	33	10.8	0	0.0	6	6.3	3	13.0
Red cord stump or with pus	7	0.9	3	0.3	763	12	2	16.7	12	3.9	0	0.0	6	6.3	2	10.0	20
Persistent vomiting	8	1.0	0	0	764	12	8	66.7	11	3.6	0	0.0	5	5.3	1	5.0	17
Low body temperature	8	1.0	0	0	764	15	6	40.0	16	5.3	0	0.0	5	5.4	3	15.0	24
Fast breathing	4	0.5	2	0.3	766	9	2	22.2	6	2.0	0	0.0	3	3.3	1	5.0	12
Severe chest in-drawings	2	0.3	3	0.4	767	5	3	60.0	10	3.3	2	11.1	6	6.3	1	5.0	19
No spontaneous movement	3	0.4	0	0	769	8	2	25.0	0	0.0	0	0.0	5	5.3	1	5.0	6
Yellowish eye, skin, sacle (jaundice)	3	0.4	0	0	769	3	3	100.0	4	1.3	0	0.0	5	5.3	3	15.0	12
Red or discharging eye	2	0.3	0	0	770	2	2	100.0	4	0.0	0	0.0	0	0.0	5	5.3	6
Lethargy	2	0.3	0	0	771	2	2	100.0	0	0.0	0	0.0	5	5.3	1	5.0	6
Unspecified	-	-	1	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	339 <sup>a</sup>	48 <sup>b</sup>	11	1.4	1,506 <sup>c</sup>	1,506 <sup>d</sup>	55 <sup>e</sup>	3.7 <sup>f</sup>	226 <sup>g</sup>	69.4 <sup>h</sup>	8	2.5	70	21.6	20	6.2	334 <sup>i</sup>

<sup>a</sup>Number of episodes of illnesses divided by the number of neonates with illnesses per row

<sup>b</sup>Total number of neonates with illnesses

<sup>c</sup>Total number of neonates with illnesses divided by all number of neonates in the study

<sup>d</sup>Total episodes of illnesses

<sup>e</sup>Total episodes of the utilization of healthcare services

<sup>f</sup>Total episodes of the utilization of healthcare services (56) divided by total episodes of illnesses (1,624)

<sup>g</sup>Total episodes of illnesses divided by the total number of neonates with illnesses

<sup>h</sup>Total number of reasons in each column divided by

<sup>i</sup>overall number of reasons (e.g., 304/437 for waited for spontaneous recovery).

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not perceive low birth weight as a problem (69%; 78 of 113 responses), or they thought that low birth weight would resolve on its own (9%; 10 of 113).

### Utilization of healthcare services during neonatal illnesses

We recorded 55 episodes of the utilization of healthcare services and 60 events of the utilization of healthcare services over 4,632 visits (i.e., total analysis time at risk). Only 2.4% (9 of 369) of ill neonates utilized healthcare services at least once during illnesses. The rate of utilization of healthcare services for any illness episode was only 3.7% (95% CI: 2.8%, 4.7%), or 55 out of 1,506 illnesses episodes. For signs of severe neonatal illnesses (i.e., cord stump with redness or pus, fast breathing, severe chest in-drawing, and high fever), only 17% utilized healthcare services for cord stump issues (2 of 12 episodes), 60% for severe chest in-drawing (3 of 5 episodes), and 22% for fast breathing (2 of 9 episodes). For signs of feeding problems, only 0.6% (8 of 1,412 episodes) utilized healthcare services. The main reasons for not utilizing healthcare services were that mothers did not perceive the illnesses as a problem (70%; 304 of 437) or could not afford to visit the healthcare institutions (4.6%; 20 of 437). Table 3 shows the results.

### Determinants of neonatal illnesses

The Prentice, Williams, and Peterson's total time Cox-type survival model analysis showed that neonates weighing  $\geq 2500$ g at birth were 0.39 times less likely to be ill (AHR = 0.39; 95% CI: 0.33, 0.46). Neonates born to mothers who walked more than 60 minutes to access the nearest hospital were three times more likely to experience an illness episode during the study period (AHR = 2.66; 95% CI: 2.12, 3.35). Table 5 shows the results.

### Determinants of utilization of healthcare services

The Prentice, Williams, and Peterson's total time Cox-type survival model analysis indicated that compared with younger mothers, older mothers with sick newborns (AHR = 1.22; 95% CI: 1.00, 1.50) or postpartum illnesses (AHR = 1.40; 95% CI: 1.03, 1.89) were more likely to seek healthcare.

### Discussion

Our study indicates that rural Ethiopian women and neonates experienced a high burden of postpartum and neonatal illnesses. For women, these illnesses included blurred vision with severe headache, excessive vaginal bleeding, severe abdominal pain, foul-smelling vaginal discharge, urinary incontinence, breast pain and engorgement, high fever, anemia, and hypertension. For neonates, these illnesses included feeding problems and diarrhea. All symptoms signal potentially dangerous illnesses in the community that must be properly diagnosed and treated. Yet, few received appropriate healthcare.

Our study involved symptom registration conducted by trained lay field workers. As such, translating these symptoms into diagnoses may be difficult. However, such symptoms can indicate a heavy illness burden in the community. For example, the estimated population of Gedeo in South Ethiopia is 1.1 million, and the crude birth rate is 31.8 of 1,000 live births [21]. Our study suggests that symptoms of potentially severe postpartum illnesses occur in about 31% of cases, and signs of severe neonatal illnesses occur in about 48% of cases. Accordingly, more than 10,800 women and 16,700 neonates in the Gedeo population should require postpartum and neonatal medical attention each year. Yet, even a smaller number of women and neonates requiring treatment would be a substantial burden on the already weak healthcare

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Table 5. Prentice, Williams, and Peterson's total time Cox-type survival model analysis for neonatal illnesses in rural southern Ethiopia, May 2017 to July 2018.

Exposure variables	Prentice-Williams-Peterson total time survival analysis					
	Status of total events (neonatal illnesses as Yes/No) n = 4,632 person-time		Crude hazard ratio (95% CI)	p-value	Adjusted hazard ratio (95% CI)	p-value
	Yes	No				
Mother's age (years)	2,214	2,418	1.00 (0.98, 1.01)	0.861	-	-
Mother's age at first marriage (years)	2,214	2,418	0.90 (0.84, 0.97)	0.007	-	-
Mother's age at first birth (years)	2,214	2,418	0.97 (0.91, 1.03)	0.294	-	-
Birth interval (years)						
2+	1,152	1,236	1.02 (0.88, 1.18)	0.799	-	-
< 2	1,062	1,182	1.0		-	-
Mother's occupation						
Other (daily laborer, farming, etc.)	234	186	1.19 (0.95, 1.48)	0.136	-	-
Domestic service	1,980	2,232	1.0		-	-
Household wealth index						
Rich	1,386	1,320	1.19 (1.02, 1.39)	0.027	-	-
Poor	828	1,098	1.0		-	-
Total household monthly expenditure						
\$30+	1,620	1,860	0.90 (0.77, 1.06)	0.218	-	-
< \$30	594	558	1.0		-	-
Mother's gravidity						
Multigravida	1,704	1,860	1.00 (0.84, 1.19)	0.989	-	-
Primigravida	510	558	1.0		-	-
Mother's parity						
Multipara	1,692	1,854	0.99 (0.83, 1.18)	0.934	-	-
Nullipara	522	564	1.0		-	-
Mother's history of abortion						
Yes	144	138	1.07 (0.80, 1.44)	0.634	-	-
No	2,070	2,280	1.0		-	-
Mother's history of stillbirth						
Yes	138	78	1.36 (1.05, 1.76)	0.020	-	-
No	2,076	2,340	1.0		-	-
Birth weight (g)	2214	2418	0.48 (0.42, 0.55)	0.001	0.39 (0.33, 0.46)	0.001
Type of road to the nearest health facility						
Asphalt	282	924	0.42 (0.32, 0.54)	0.001	-	-
Other	1,932	1,494	1.0		-	-
Walking distance to the nearest health post in minutes						
30+	1,344	732	1.90 (1.63, 2.22)	0.001	-	-
<30	870	1,686	1.0		-	-
Walking distance to the nearest health center in minutes						
40+	1,110	474	1.94 (1.68, 2.23)	0.001	-	-
<40	1,104	1,944	1.0		-	-
Walking distance to the nearest hospital in minutes						
60+	1,584	666	2.66 (2.23, 3.18)	0.001	2.66 (2.12, 3.35)	0.001
<60	630	1,752	1.0		1.0	

Significant at  $p < 0.05$ ; CI = confidence interval.<https://doi.org/10.1371/journal.pone.0237852.t005>

system [39]. It is therefore essential that efforts to address these issues ensure appropriate healthcare for ill women and neonates [40].

In this study, four in five women experienced at least one postpartum illness. This incidence rate was higher than in a previous study from rural India [41]. Many recurring episodes of symptoms were recorded during the study period, revealing a potentially high burden of postpartum illnesses in this area. This finding suggests that the healthcare system should be prepared for early identification and intervention.

The presence of many mildly anemic and a few severely anemic women might be due to excessive postpartum bleeding, lack of iron and folic acid supplementation, and pre-existing anemia.

Objectively measuring excessive vaginal bleeding is difficult in a survey setting, however, and clinical assessments tend to underestimate or overestimate actual volume loss. Nevertheless, one in five women has anemia, which can cause fatigue and other symptoms, and measuring hemoglobin levels is not commonly done in these communities. Similar to our previous study [22], we also demonstrated that most women did not receive iron or folate supplementation after childbirth, as advised by national policy. The burden of anemia in the community may serve as another indicator that the healthcare system should be strengthened.

The rate of postpartum illnesses in our study was lower than that found in studies from Pakistan [4] and India [6]. This gap could be due to differences in the study population, study design, and study setting. The studies from India and Pakistan included women either from home or healthcare facilities, whereas we did multiple visits at home and focused on both severe and minor forms of postpartum illnesses. However, the incidence of postpartum illnesses in our study was higher than that found in Jamaica, Kenya, and Malawi [7].

About 32% of poor women experienced one or more postpartum illnesses; however, fewer poor women received healthcare compared to rich women. The risk factors for postpartum illness were comparable to those from a previous study that documented women's age at first marriage, women's age at first birth, wealth index, and walking distance to the nearest healthcare institution as significant factors [8]. However, that study was based on cross-sectional data from healthcare facilities and did not focus on women from rural communities. Factors such as home delivery and parity also contribute to a high burden of postpartum illnesses [42]. Our study further suggests that age can influence the utilization of healthcare services [8]. This finding from our study needs further research to better reveal the factors related to illnesses after childbirth and to inform policy-makers.

In our study, the incidence of neonatal illnesses was higher than in recent studies from Bangladesh [15] and India [16]. This difference in incidence rates could be due to the study design, as our study was a cohort study, and the studies from Bangladesh and India were cross-sectional and assessed neonatal illnesses at a point in time. This might also be due to the high prevalence of home deliveries, in which many of the ill-neonates might not be followed, identified, treated, or referred to at the community level.

The common neonatal symptoms we reported include high fever, difficult or fast breathing, low temperature, poor sucking or feeding, chest in-drawing, and jaundice [16] which were in line with recent studies from Bangladesh [15] and India [16]. Factors such as geographic location and household wealth status [8] contribute to a high burden of neonatal illnesses. Our study further suggests that residence, low birth weight, type of road access, and walking distance were associated with neonatal illnesses.

The rate of low birth weight in this study is similar to other studies in Ethiopia [43] and was in our study expected to be a risk factor for neonatal illnesses. However, because few of the neonates with low birth weight sought healthcare, our study was underpowered to do such analyses.

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The low rate of healthcare-seeking behavior remains a key challenge to improving neonatal health in developing countries [44]. In Bangladesh, less than 5% of neonates with illnesses visit a healthcare institution [45]. Contributing factors to this low rate include mother's poor recognition of illnesses, distance to a healthcare facility, and financial constraints [46]. We similarly found that the mother's perception of the severity of symptoms was another key challenge to seeking healthcare for her child, along with financial problems and beliefs that healthcare was not necessary, the latter of which may be due to previous exposure to poor or lacking healthcare services. Together, these findings suggest that efforts are needed to strengthen the provision of neonatal healthcare at the community level. Informing and teaching mothers and women about the use of health services is important. The health extension system combined with the local women's associations and networks in their communities (kebeles) gives us an opportunity to improve the health-seeking habits of mothers.

Our study has some limitations. We included only those women who attended two or more antenatal care visits, which may have caused selection bias, as discussed in our previous study [22]. Thus, our study may not be fully representative, as women or neonates born to mothers who did not receive antenatal care could have a higher incidence of illnesses and lower utilization of healthcare services. Also, we did not register the type and quality of postpartum and neonatal healthcare services provided by the health extension workers.

Although women in Ethiopia usually schedule antenatal care in late pregnancy or not at all [21], we were able to include more than 75% of pregnant women in the study areas in our analysis. However, we investigated a limited range of disorders and did not collect information on vaginal tears, anal incontinence, voiding difficulties, hemorrhoids, sexual problems, wound breakdown, backache, and constipation. In general, our registration of symptoms was based on subjective reports by the women.

The main strength of the study is that the follow-up was done at the women's homes or places they reside in. This study presents a prospective measurement of postpartum and neonatal illnesses in a rural area. This information has not been well documented at the community level and has been considered infeasible to study as it is considered as costly. Because the research teams consisted of residents of the same villages, they were well accepted by the population and could be present at the time of any illnesses.

Unlike previous studies, this study includes conditions during the pregnancy, postpartum, and neonatal periods. This coverage provides a comprehensive picture of health problems in women and neonates and helps inform policy decision-making. The target populations for these policies are similar to the study population concerning geographic, temporal, and ethnic variables. The findings of this study thus may generalize best to similar settings with poor and rich women and neonates, women and mothers of neonates with and without formal education, and women and mothers of neonates of different ages.

## Conclusions

The burden of postpartum and neonatal illnesses in rural communities in southern Ethiopia remains high. Unfortunately, a substantial proportion of ill neonates and women did not utilize healthcare services due to challenges in access to appropriate healthcare services. In terms of policy implications, our findings could serve as a basis for more detailed interventions in Ethiopia and provide useful insights concerning illnesses during the postpartum and neonatal periods. Low utilization of healthcare services appears to be an important area that needs immediate intervention.

Therefore, the efforts of the Ministry of Health should be directed towards strengthening the health system that enables in identifying, managing, treating, and referring maternal and



neonatal illnesses and provide a reasonable level of healthcare at the community level. Interventions could include the promotion of health education that encourages women and mothers to seek appropriate and timely healthcare, increases the percentage of women and neonates receiving healthcare during illnesses, and ensures maternal and neonatal health during the postpartum and neonatal periods.

The Ethiopian health extension program was developed in a context in which maternal and neonatal health outcomes and coverage of essential healthcare services are very poor [18]. However, we did not study the healthcare system in the context of postpartum and neonatal illnesses. Thus, the content and quality of services provided by health extension workers at the community-level were not assessed. We also did not study the knowledge and skill of health extension workers in identifying and managing these illnesses and their related factors could constitute a potential future research area. For example, the tool used in our study could be used by health extension workers during their scheduled home visits to identify and assess illnesses among postpartum women and their neonates [33]. Therefore, more work is needed to enable the health system in identifying, managing, treating, and referring ill-women and neonates in need of healthcare services at the community level.

### Supporting information

**S1 Fig. The flowchart of the recruitment of participants.**  
(TIFF)

**S1 Table. Symptoms of postpartum illnesses.**  
(DOC)

**S2 Table. Symptoms of neonatal illnesses.**  
(DOC)

**S1 File. Gedeo questionnaire for postpartum women and neonates.**  
(RAR)

**S2 File. Amharic questionnaire for postpartum women.**  
(RAR)

**S3 File. English questionnaire for postpartum women.**  
(RAR)

**S4 File. Amharic questionnaire for neonates.**  
(RAR)

**S5 File. English questionnaire for neonates.**  
(RAR)

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**Writing – review & editing:** Moges Tadesse Borde, Eskindir Loha, Bernt Lindtjorn.

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## Appendix II: Questionnaires for Paper II

**Form 3: Delivery questionnaire**

Household characteristics	
House ID	[____/____/____/____/____/____]
Woman ID	2.
Kebele/village (Name)	1) Mekonisa    2) Tumata chiricha    3)Hase haro
Sub-kebele	
Date interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview:	1. Completed    2. No delivered woman at home    3. No all family at home    4. Another appointment    5. Refused
Date of delivery (DD/MM/YYYY).....	

Section 1: Background characteristics of the delivered woman																											
No.	Questions and Filters	Coding Categories	SKIP																								
301.	Would you tell me the duration of your labour? ( hours)	1. <12 hours 2. >12 hours																									
302.	How many hours before the baby was born did the water break?	1. <24 hours 2. >24 hours 98. Don't know																									
303.	How did the water smell and look?	1. No odour/normal odour and clear 2. Foul smell and green 98. Don't know																									
304.	Where did you give the current birth?	<table border="0"> <tr> <td></td> <td style="text-align: center;">No</td> <td style="text-align: center;">Yes</td> </tr> <tr> <td>7. Home</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>8. Family home</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>9. Health post</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>10. Health centre</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>11. Hospital</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>12. Private clinic</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>99. Other.....</td> <td></td> <td></td> </tr> </table>		No	Yes	7. Home	0	1	8. Family home	0	1	9. Health post	0	1	10. Health centre	0	1	11. Hospital	0	1	12. Private clinic	0	1	99. Other.....			If home delivery, SKIP to 306
	No	Yes																									
7. Home	0	1																									
8. Family home	0	1																									
9. Health post	0	1																									
10. Health centre	0	1																									
11. Hospital	0	1																									
12. Private clinic	0	1																									
99. Other.....																											
305.	How did you reach to the place of birth?	1. On foot 2. Ambulance 3. Cart 99. Other.....																									
306.	If 304 at home, what was the reason you didn't deliver in a health facility?  Do Not Read Out Responses  PROBE: Any other reason?	<table border="0"> <tr> <td></td> <td style="text-align: center;">No</td> <td style="text-align: center;">Yes</td> </tr> <tr> <td>1. Preferred to deliver at home</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>2. Cost too much</td> <td style="text-align: center;">0.</td> <td style="text-align: center;">1</td> </tr> <tr> <td>3. Too far/ no transportation</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>4. Not necessary</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>5. Not customary</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>6. Delivered on way to health facility</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>99. Other .....</td> <td></td> <td></td> </tr> </table>		No	Yes	1. Preferred to deliver at home	0	1	2. Cost too much	0.	1	3. Too far/ no transportation	0	1	4. Not necessary	0	1	5. Not customary	0	1	6. Delivered on way to health facility	0	1	99. Other .....			
	No	Yes																									
1. Preferred to deliver at home	0	1																									
2. Cost too much	0.	1																									
3. Too far/ no transportation	0	1																									
4. Not necessary	0	1																									
5. Not customary	0	1																									
6. Delivered on way to health facility	0	1																									
99. Other .....																											
307.	How long after the baby's birth did the placenta come out? (If it is by c-section, circle "<1 hour")	1. <1 hour 2. >1 hour																									
308.	What was the mode of delivery?	1. Normal labour (vaginal) 2. Vaginal instrument (vacuum, forceps) 3. Caesarean section 99. Other.....																									
309.	Who helped during the current birth?	<table border="0"> <tr> <td></td> <td style="text-align: center;">No</td> <td style="text-align: center;">Yes</td> </tr> <tr> <td>1. Traditional birth attendant</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>2. Family (friend)</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>3. Health extension worker</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> </table>		No	Yes	1. Traditional birth attendant	0	1	2. Family (friend)	0	1	3. Health extension worker	0	1													
	No	Yes																									
1. Traditional birth attendant	0	1																									
2. Family (friend)	0	1																									
3. Health extension worker	0	1																									

		4. Health Professional (midwife, nurse, Dr)	0	1	
Section 2: Illness questions during delivery					
310.	During delivery, did you notice any of this maternal illness?		<u>No</u>	<u>Yes</u>	
	<i>Read each option and mark yes or no.</i>	1. Excessive vaginal bleeding	0	1	
		2. Baby's hand or feet come first	0	1	
		3. Prolonged labour >12 hours	0	1	
		4. Convulsions	0	1	
		5. Fever	0	1	
		6. Baby in abnormal position	0	1	
		7. Retained placenta	0	1	
		8. Ruptured uterus	0	1	
		9. Prolapsed cord	0	1	
		10. Cord around neck	0	1	
		99. Other .....			
Section 3: Health service Utilisation					
311.	Did you go to for treatment?	0. No			If no, SKIP to 319
		1. Yes			
312.	Where did you go?		<u>No</u>	<u>Yes</u>	
		6. Health post	0	1	
		7. Health centre	0	1	
		8. Hospital	0	1	
		9. Private	0	1	
		10. Traditional healer	0	1	
		99. Other.....			
313.	Please, can you tell me the name of the institution?	Name.....			
314.	Have you been registered in the registration book of the institute?	0. No			Please, look the card and compare with registration book
		1. Yes			
315.	How many times did you go for treatment?	.....			
316.	What type of treatment did you get?	.....			
317.	In how many days, did you go to a health facility?	.....(days)			
318.	Have you been referred?	4. Not referred			
		5. Yes to the health centre			
		6. Yes to hospital			
319.	If no in 311, if you did you not go, what was the reason?	11. Thought that it resolved by itself			
		12. The illness was not serious			
		13. Lack of money			
		14. Lack of confidence in the health facility			
		15. Health service is not good			
		101. Others.....			
Section 4: Diagnosis to done by our field nurse					
320.	Blood pressure systolic (mmHg)				
321.	Blood pressure diastolic (mmHg)				
322.	Pulse rate				
323.	Body temperature (°C)				

Thank you!!

**Form 4: Postnatal illness assessment baseline questionnaire**

Household characteristics	
House ID	[ ___ / ___ / ___ / ___ / ___ / ___ ]
Woman ID	2.
Kebele/village (Name)	1) Mekonisa    2) Tumata chiricha    3) Hase haro
Sub-kebele	
Date interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview:	1. Completed    2. No delivered woman at home    3. No all family at home    4. Another appointment    5. Refused
Date of delivery (DD/MM/YYYY).....	

Section 1: Background characteristics of the delivered woman				
No.	Questions and Filters	Coding Categories	SKIP	
401.	After the birth of your baby, did any health care provider check your health?	0. No 1. Yes	If no, SKIP to 405	
402.	Was it before or after discharge from the facility?	1. Before 2. After		
403.	Who gave you the health check? <i>Probe: What type of health care provider?</i>	.....		
404.	How long after the delivery was this done?	-----  _ _  Minutes  _ _  Hours  _ _  Days  _ _  Weeks  _ _  Months		
405.	Did the health care provider take your temperature?	0. No            1. Yes		
406.	Did the health care provider check for bleeding?	0. No            1. Yes		
407.	Did the health care provider check your breasts?	0. No            1. Yes		
408.	Did the health care provider check your blood pressure?	0. No 1. Yes		
409.	Did the health care provider talk to you about danger signs after delivery or when you need to see a doctor?	0. No 1. Yes		
410.	Did the health care provider talk to you about breastfeeding?	0. No 1. Yes		
411.	Did the health care provider talk to you about family planning?	0. No 1. Yes		
412.	During this postnatal period were you given, or did you buy any iron tablets or syrup? SHOW TABLETS	2. No 3. Yes	If no, SKIP to 414	
413.	If you bought it, how much is it?	.....birr		
414.	During this postnatal period were you given, or did you buy any folic acid tablets? SHOW TABLETS	2. No 3. Yes	If no, SKIP to 416	
415.	If you bought it, how much is it?	.....birr		
Section 2: postnatal Illness assessment baseline questions				
416.	In the last 2 weeks, were you sick of the following illnesses?			
			No Yes	
		1. Convulsion	0	1
		2. Excessive vaginal bleeding	0	1
		3. Foul vaginal discharge	0	1
		4. High Fever (infection)	0	1
		5. Blurred vision with severe headache	0	1
		6. Severe abdominal pain	0	1
		7. Excessive tiredness or breathlessness	0	1
		8. Painful, engorged breasts or sore	0	1
	9. Micturition and urinary incontinence	0	1	
	99. Other (mention)			
417.	Were you sick of malaria in the last 2 weeks?	3. No 4. Yes	If no, SKIP to 422	

418.	Would you tell us the duration of the illness?	.....(days)																						
419.	Have your blood tested for malaria?	3. No                      1. Yes	If no, SKIP to 421																					
420.	Were you positive for malaria?	3. No                      1. Yes	If yes, go to and check-in health post-registration book																					
421.	Have you taken a malaria drug?	3. No                      1. Yes																						
422.	Had you cough in the last 2 weeks?	3. No                      1. Yes	If no, SKIP to 428																					
423.	Would you tell us the duration of the illness?	.....(days)																						
424.	Did you have an unusual difficulty of breathing or fast breathing?	3. No                      1. Yes																						
425.	Did the breathing difficulty or fast breathing from the chest or it include blocking the nose	7. Chest only 8. Nose only 9. Both chest and nose																						
426.	Were you examined by a health professional?	3. No                      1. Yes	If yes, go to and check-in health post-registration																					
427.	Had you taken the drug?	3. No                      1. Yes																						
<b>2: Health service Utilisation</b>																								
428.	Did you go to a health facility for treatment?	0. No                      1. Yes	If no, SKIP to 436																					
429.	Where did you go?	<table border="1"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr> <td>9. Health post</td> <td>0</td> <td>1</td> </tr> <tr> <td>10. Health centre</td> <td>0</td> <td>1</td> </tr> <tr> <td>11. Hospital</td> <td>0</td> <td>1</td> </tr> <tr> <td>12. Private</td> <td>0</td> <td>1</td> </tr> <tr> <td>13. Traditional healer</td> <td>0</td> <td>1</td> </tr> <tr> <td>99. Other (mention)</td> <td></td> <td></td> </tr> </tbody> </table>		No	Yes	9. Health post	0	1	10. Health centre	0	1	11. Hospital	0	1	12. Private	0	1	13. Traditional healer	0	1	99. Other (mention)			
	No	Yes																						
9. Health post	0	1																						
10. Health centre	0	1																						
11. Hospital	0	1																						
12. Private	0	1																						
13. Traditional healer	0	1																						
99. Other (mention)																								
430.	Please, can you tell me the name of the institution?	Name.....																						
431.	Have you been registered in the registration book of the institute?	0. No 1. Yes	Please, look the card and compare with registration book																					
432.	How many times did you go for treatment?	.....																						
433.	What type of treatment did you get?	.....																						
434.	In how many days, did you go to a health facility?	.....(days)																						
435.	Have you been referred?	7. Not referred 8. Yes to the health centre 9. Yes to hospital																						
436.	If you did you not go to a health institution, what was the reason?	16. Thinking that it resole by itself 17. The illness was not serious 18. Lack of money 19. Lack of confidence in health facility 20. Health service is not good 102. Others																						
<b>Section 4: Diagnosis to be done by our field nurse</b>																								
437.	Blood pressure systolic (mmHg)																							
438.	Blood pressure diastolic (mmHg)																							
439.	Pulse rate																							
440.	Haemoglobin (g/dl) (between 5 <sup>th</sup> and 6 <sup>th</sup> week of delivery)		If < 5 <sup>th</sup> and > 6 <sup>th</sup> week, SKIP to 441																					
441.	Body temperature (°C)																							

Thank you!!





	the institute?		compare with registration book
517.	How many times did you go for treatment?	.....	
518.	What type of treatment did you get?	.....	
519.	In how many days, did you go to a health facility?	.....(days)	
520.	Have you been referred?	10. Not referred 11. Yes to the health centre 12. Yes to hospital	
521.	If no in 513, if you did not go to health institutions, what was the reason?	21. Thinking that it resole by itself 22. The illness was not serious 23. Lack of money 24. Lack of confidence in the health facility 25. Health service is not good 103. Others	
Section 3: PNC history			
522.	During this pregnancy were you given, or did you buy any iron tablets or iron syrup? SHOW TABLETS	4. No                      1. Yes	If no, SKIP to 524
523.	If you bought it, how much is it?	.....birr	
524.	During this pregnancy were you given, or did you buy any folic acid tablets? SHOW TABLETS	4. No                      1. Yes	If no, SKIP to 526
525.	If you bought, how much is it?	.....birr	
Section 4: Diagnosis to be done by our field nurse			
526.	Blood pressure systolic (mmHg)		
527.	Blood pressure diastolic (mmHg)		
528.	Pulse rate		
529.	Body temperature (°C)		
530.	Haemoglobin (g/dl) (between 5 <sup>th</sup> and 6 <sup>th</sup> week of delivery)		If < 5 <sup>th</sup> and > 6 <sup>th</sup> week, SKIP it

Thank you!!

**Form 6. Neonatal illness assessment baseline questionnaire**

Household characteristics	
House ID	[____/____/____/____/____/____]
Neonate ID	3. Single 4. If twins, to the second child 5. If triplet, to the third child
Kebele/village (Name)	1) Mekonisa 2) Tumata chiricha 3)Hase haro
Sub-kebele	
Date of interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview:	1. Completed 2. No mother at home 3. No all family at home 4. Another appointment 5. Refused
Date of birth (DD/MM/YYYY).....	

Section 1: Background characteristics of the neonate			
No.	Questions and Filters	Coding Categories	SKIP
701.	How old is your neonate?	If < 30 days, record baby's age in days, Days [ _ _ ] If greater than 30 days record in weeks, weeks [ _ _ ]	
702.	What is the sex of the neonate?	1. Female 2. Male	
703.	Where was the neonate born?	13. Home 14. Family home 15. Health post 16. Health centre 17. Hospital 99. Other (mention)	
704.	How many were born in this birth?	1. Singleton 2. Twins 3. Triple 4. Multiple	
705.	The outcome of this pregnancy?	1. Miscarriage 2. Stillbirth 3. Live birth	
706.	Is the neonate alive or deceased?	1. Alive 2. Deceased	
707.	Was (NAME) born early, late, or at the expected time?	1. Early 2. On-time 3. Late	
708.	After how many completed months of pregnancy was (NAME) born?	[ _ ] months	
709.	What was the child's condition at birth?	1. Alive and normal 2. Stillbirth 99. Other (mention)	
710.	Did the neonate feed the colostrums?	0. No 1. Yes	
711.	After the birth of your baby, did any health care provider check his/her health?	0. No 1. Yes	
712.	Was it before or after discharge from the facility?	1. Before 2. After	
713.	Who gave your baby the health check? <i>Probe: What type of health care provider?</i>	.....	
714.	How long after the delivery was this done?	[ _ ] Minutes [ _ ] Hours [ _ ] Days [ _ ] Weeks [ _ ] Months	
715.	Did the health care provider take your baby's temperature?	0. No 1. Yes	
716.	Did the health care provider check your baby's breathing?	0. No 1. Yes	
717.	Did the health care provider check your baby's	0. No	

	umbilical cord?	1. Yes																																														
718.	Did the health care provider ask if the baby had any convulsions?	0. No 1. Yes																																														
719.	Did the health care provider advise you on baby care?	0. No 1. Yes																																														
720.	Did the health care provider advise you on immunizations?	0. No 1. Yes																																														
721.	If there is no health check, why?																																															
<b>Section 2: Neonatal illness assessment questions</b>																																																
722.	Is the last 2 weeks; is your neonate sick of the following illnesses?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr><td>1. Not sucking properly</td><td>0</td><td>1</td></tr> <tr><td>2. Convulsion</td><td>0</td><td>1</td></tr> <tr><td>3. Fast breathing (breathing rate <math>\geq 60</math> per minute)</td><td>0</td><td>1</td></tr> <tr><td>4. Difficult to wake up, no spontaneous movement</td><td>0</td><td>1</td></tr> <tr><td>5. Red cord stump or with pus</td><td>0</td><td>1</td></tr> <tr><td>6. Severe chest in-drawing</td><td>0</td><td>1</td></tr> <tr><td>7. Fever (temperature <math>\geq 37.5</math> °C)</td><td>0</td><td>1</td></tr> <tr><td>8. Low body temperature (temperature <math>&lt; 35.5</math> °C)</td><td>0</td><td>1</td></tr> <tr><td>9. Red/ discharging eye</td><td>0</td><td>1</td></tr> <tr><td>10. Yellowish eye, skin, palms and soles</td><td>0</td><td>1</td></tr> <tr><td>11. Lethargy</td><td>0</td><td>1</td></tr> <tr><td>12. Diarrheal</td><td>0</td><td>1</td></tr> <tr><td>13. Persistent vomiting</td><td>0</td><td>1</td></tr> <tr><td>99. Other (mention)</td><td></td><td></td></tr> </tbody> </table>		No	Yes	1. Not sucking properly	0	1	2. Convulsion	0	1	3. Fast breathing (breathing rate $\geq 60$ per minute)	0	1	4. Difficult to wake up, no spontaneous movement	0	1	5. Red cord stump or with pus	0	1	6. Severe chest in-drawing	0	1	7. Fever (temperature $\geq 37.5$ °C)	0	1	8. Low body temperature (temperature $< 35.5$ °C)	0	1	9. Red/ discharging eye	0	1	10. Yellowish eye, skin, palms and soles	0	1	11. Lethargy	0	1	12. Diarrheal	0	1	13. Persistent vomiting	0	1	99. Other (mention)			
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99. Other (mention)																																																
723.	Was your child sick of malaria in the last 2 weeks?	6. No 7. Yes	If no, SKIP to 728																																													
724.	If yes, would you tell us the duration of the illness?	.....(days)																																														
725.	Has his/her blood tested for malaria?	5. No 6. Yes	If no, SKIP to 727																																													
726.	If yes, was positive for malaria?	5. No 6. Yes	If yes, go to and check-in health post-registration book																																													
727.	Has he/she given a malaria drug?	5. No 6. Yes																																														
728.	Has your child cough in the last 2 weeks?	5. No 6. Yes	If no, SKIP to 734																																													
729.	If yes, would you tell us the duration of the illness?	.....(days)																																														
730.	Did he/she have an unusual difficulty of breathing or fast breathing?	5. No 6. Yes																																														
731.	Did the breathing difficulty or fast breathing from the chest or it include blocking the nose	13. Chest only 14. Nose only 15. Both chest and nose																																														
732.	Were your child examined by a health professional?	5. No 6. Yes	If yes, go to and check-in health post-registration																																													
733.	Has he/she given a drug?	5. No 6. Yes																																														
<b>Section 3: Health service Utilisation</b>																																																
734.	If no in 728, Did you seek advice or treatment for the illness outside the home?	0. No 1. Yes	If no, SKIP to 742																																													
735.	Where did you go?	<table border="0"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr><td>19. Health post</td><td>0</td><td>1</td></tr> <tr><td>20. Health centre</td><td>0</td><td>1</td></tr> <tr><td>21. Hospital</td><td>0</td><td>1</td></tr> <tr><td>22. Traditional healer</td><td>0</td><td>1</td></tr> <tr><td>99. Other (mention)</td><td></td><td></td></tr> </tbody> </table>		No	Yes	19. Health post	0	1	20. Health centre	0	1	21. Hospital	0	1	22. Traditional healer	0	1	99. Other (mention)																														
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736.	Please, can you tell me the name of the institution?	Name.....																																														

737.	Has your child been registered in the registration book of the institute?	0. No 1. Yes	Please, look the card and compare with registration book																					
738.	How many times did your child go?	.....																						
739.	What type of treatment?	.....																						
740.	In how many days, did you go to a health facility?	.....(days)																						
741.	Has your neonate been referred?	13. Not referred 14. Yes to the health centre 15. Yes to hospital																						
742.	If no in 734, If not, why didn't you seek care for your neonate outside your home?	<table border="0"> <tr> <td></td> <td style="text-align: right;"><u>No</u></td> <td style="text-align: right;"><u>Yes</u></td> </tr> <tr> <td>1. Expecting self resolution of the illness</td> <td style="text-align: right;">0</td> <td style="text-align: right;">1</td> </tr> <tr> <td>2. Health facility too far/no transportation</td> <td style="text-align: right;">0</td> <td style="text-align: right;">1</td> </tr> <tr> <td>3. Cost of treatment service high</td> <td style="text-align: right;">0</td> <td style="text-align: right;">1</td> </tr> <tr> <td>4. Don't trust facility/poor quality of care</td> <td style="text-align: right;">0</td> <td style="text-align: right;">1</td> </tr> <tr> <td>5. Not customary to seek care</td> <td style="text-align: right;">0</td> <td style="text-align: right;">1</td> </tr> <tr> <td>99. Other (Specify) .....</td> <td></td> <td></td> </tr> </table>		<u>No</u>	<u>Yes</u>	1. Expecting self resolution of the illness	0	1	2. Health facility too far/no transportation	0	1	3. Cost of treatment service high	0	1	4. Don't trust facility/poor quality of care	0	1	5. Not customary to seek care	0	1	99. Other (Specify) .....			
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743.	Weight (Kg)																							
744.	Body temperature (°C)																							
745.	Height (cm)																							

Thank you!!!

**Form 7. Neonatal illness assessment follow-up questionnaire**

Household characteristics	
House ID	[____/____/____/____/____/____]
Neonate ID	3. Single) 4. If twins, to the second child 5. If triplet, to the third child
Kebele/village (Name)	1) Mekonisa 2) Tumata chiricha 3) Hase haro
Sub-kebele	
Date of interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview: 1. Completed 2. No mother at home 3. No all family at home 4. Another appointment 5. Refused	

Section 1: neonatal illness questions		Response	Remark																																													
No.	Questions and Filters	Coding Categories	SKIP																																													
801.	In the last 2 weeks, did your neonate have the following illness?	<table border="1"> <thead> <tr> <th></th> <th>No</th> <th>Yes</th> </tr> </thead> <tbody> <tr><td>14. Not sucking properly</td><td>0</td><td>1</td></tr> <tr><td>15. Convulsion</td><td>0</td><td>1</td></tr> <tr><td>16. Fast breathing (breathing rate <math>\geq 60</math> per minute)</td><td>0</td><td>1</td></tr> <tr><td>17. Difficult to wake up, no spontaneous movement</td><td>0</td><td>1</td></tr> <tr><td>18. Red cord stump or with pus</td><td>0</td><td>1</td></tr> <tr><td>19. Severe chest in-drawing</td><td>0</td><td>1</td></tr> <tr><td>20. Fever (temperature <math>\geq 37.5</math> °C)</td><td>0</td><td>1</td></tr> <tr><td>21. Low body temperature (temperature <math>&lt; 35.5</math> °C)</td><td>0</td><td>1</td></tr> <tr><td>22. Red/ discharging eye</td><td>0</td><td>1</td></tr> <tr><td>23. Yellowish eye, skin, palms and soles</td><td>0</td><td>1</td></tr> <tr><td>24. Lethargy</td><td>0</td><td>1</td></tr> <tr><td>25. Diarrheal</td><td>0</td><td>1</td></tr> <tr><td>26. Persistent vomiting</td><td>0</td><td>1</td></tr> <tr><td>99. Other (mention).....</td><td></td><td></td></tr> </tbody> </table>		No	Yes	14. Not sucking properly	0	1	15. Convulsion	0	1	16. Fast breathing (breathing rate $\geq 60$ per minute)	0	1	17. Difficult to wake up, no spontaneous movement	0	1	18. Red cord stump or with pus	0	1	19. Severe chest in-drawing	0	1	20. Fever (temperature $\geq 37.5$ °C)	0	1	21. Low body temperature (temperature $< 35.5$ °C)	0	1	22. Red/ discharging eye	0	1	23. Yellowish eye, skin, palms and soles	0	1	24. Lethargy	0	1	25. Diarrheal	0	1	26. Persistent vomiting	0	1	99. Other (mention).....			
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99. Other (mention).....																																																
802.	Was your child sick of malaria in the last 2 weeks?	8. No 9. Yes	If no, SKIP to 807																																													
803.	Would you tell us the duration of the illness?	.....(days)																																														
804.	Has his/her blood tested for malaria?	7. No 8. Yes	If no, SKIP to 806																																													
805.	Was it positive for malaria?	7. No 8. Yes	If yes, go to and check-in health post-registration book																																													
806.	If no in 804, has he/she given a malaria drug?	7. No 8. Yes																																														
807.	If no in 802, has your child cough in the last 2 weeks?	7. No 8. Yes	If no, SKIP to 813																																													
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813.	If no in 807, did you seek advice or treatment for the illness outside the home?	0. No 1. Yes	If no, SKIP to 821																																													

814.	Where did you go?	<table border="0"> <tr> <td></td> <td style="text-align: center;"><u>No</u></td> <td style="text-align: center;"><u>Yes</u></td> </tr> <tr> <td>23. Health post</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>24. Health centre</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>25. Hospital</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>26. Private</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>27. Traditional healer</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>99. Other (mention)</td> <td></td> <td></td> </tr> </table>		<u>No</u>	<u>Yes</u>	23. Health post	0	1	24. Health centre	0	1	25. Hospital	0	1	26. Private	0	1	27. Traditional healer	0	1	99. Other (mention)			
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822.	Bodyweight (Kg)																							
823.	Body temperature (°C)																							
824.	Height (cm)																							

Thank you!!

## Supplementary information II: for Paper II

## Paper II. Definition of postpartum and neonatal illness

Table 5.b. Definition of postpartum illness

Type	Definition
Visual disturbances/blurred vision with headache	A vision disorder with an impairment of the sense of vision
Excessive vaginal bleeding >2 or days	A mother used > five pads a day or an increase in the use of pads (by at least 2). The blood has no difference in the colour from red to pink, then brown, and finally to a yellowish-white.
Severe abdominal pain	Stomach ache
Foul vaginal discharge/itching :	A fluid with burning during micturition, rash, and/or odour due to infection of the genital tract
Urinary incontinence	Urine leaks during exerting pressure on the bladder by coughing, sneezing, laughing, or lifting something heavy.
Painful, engorged breast or sore in breast	Breast engorgement is the development of hard, swollen, painful breasts from too much breast milk. Either cracked nipples or painful lumps in breast or difficulties in breastfeeding.
Fatigue/Tiredness	A subjective feeling of tiredness
High fever	Temperature > 37.5 °C on any day
Anaemia	A postpartum woman was considered anaemic if the Hb concentration was less than 12 g/dl
Hypertension	Either a systolic or a diastolic blood pressure measurement higher than an accepted normal value

Table 5.c: Definition of neonatal illness

Type	Definition
Not sucking properly	Baby breastfeeding problems
Fast breathing	Fast breathing rate ≥60 per minute
Difficult to wake up	Difficult to wake up as the baby is unusually quiet or baby is sluggish when awake
No spontaneous movement	The baby has no spontaneous reflexes such as sucking, crying, and swallowing
Infected cord	The cord is infected or with pus within the first two weeks
severe chest in drawings	Inward movement of the lower chest wall (i.e., ribs) when the child breathes in and is a sign of respiratory distress
High fever	Temperature > 37.5 °C on any day
Low body temperature	Temperature < 35.5 °C on any day
Eye infection	Red-eye or discharging eye
Jaundice	Yellowish eye, skin, palms and soles
Lethargy	To have little or no energy, are drowsy or sluggish, and may sleep longer than usual
Diarrhoea	Having 2 or more watery or very loose stools
Persistent vomiting	Forceful throwing up of stomach contents through the mouth




Paper III

## RESEARCH

## Open Access

# Financial risk of seeking maternal and neonatal healthcare in southern Ethiopia: a cohort study of rural households

Moges Tadesse Borde<sup>1,2,3\*</sup> , Eskindir Loha<sup>1,4</sup>, Kjell Arne Johansson<sup>5</sup> and Bernt Lindtjøm<sup>1,2</sup>**Abstract**

**Introduction:** Ethiopian households' out-of-pocket healthcare payments constitute one-third of the national healthcare budget and are higher than the global and low-income countries average, and even the global target. Such out-of-pocket payments pose severe financial risks, can be catastrophic, impoverishing, and one of the causal barriers for low utilisation of healthcare services in Ethiopia. This study aimed to assess the financial risk of seeking maternal and neonatal healthcare in southern Ethiopia.

**Methods:** A population-based cohort study was conducted among 794 pregnant women, 784 postpartum women, and their 772 neonates from 794 households in rural *kebeles* of the *Wonago* district, southern Ethiopia. The financial risk was estimated using the incidence of catastrophic healthcare expenditure, impoverishment, and depth of poverty. Annual catastrophic healthcare expenditure was determined if out-of-pocket payments exceeding 10% of total household or 40% of non-food expenditure. Impoverishment was analysed based on total household expenditure and the international poverty line of  $\approx$  \$1.9 per capita per day.

**Results:** Approximately 93% (735) of pregnant women, 31% (244) of postpartum women, and 48% (369) of their neonates experienced illness. However, only 56 households utilised healthcare services. The median total household expenditure was \$527 per year (IQR = 390: 370,760). The median out-of-pocket healthcare payment was \$46 per year (IQR = 46: 46, 92) with two episodes per household, and shared 19% of the household's budget. The poorer households paid more than did the richer for healthcare, during pregnancy-related and neonatal illness. However, the richer paid more than did the poorer during postpartum illness. Forty-six percent of households faced catastrophic healthcare expenditure at the threshold of 10% of total household expenditure, or 74% at a 40% non-food expenditure, and associated with neonatal illness (aRR: 2.56, 95%CI: 1.02, 6.44). Moreover, 92% of households were pushed further into extreme poverty and the poverty gap among households was 45 Ethiopian Birr per day. The average household size among study households was 4.7 persons per household.

(Continued on next page)

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(Continued from previous page)

**Conclusions:** This study demonstrated that health inequity in the household's budget share of total OOP healthcare payments in southern Ethiopia was high. Besides, utilisation of maternal and neonatal healthcare services is very low and seeking such healthcare poses a substantial financial risk during illness among rural households. Therefore, the issue of health inequity should be considered when setting priorities to address the lack of fairness in maternal and neonatal health.

**Keywords:** Financial risk, Maternal and neonatal healthcare, Southern Ethiopia, Cohort study, Rural households

## Background

Among the primary objectives of healthcare systems are to treat sick people and protect them from financial risk [1]. Tax systems and health insurance are major mechanisms that pool financial risk and assure more predictable healthcare finances [2]. However, households with tight financial constraints in low and middle-income countries (LMICs) still pay high levels of direct out-of-pocket (OOP) healthcare payments during illness [3] at the point of seeking healthcare [4]. Moreover, there is low coverage or utilisation of healthcare services during illness, and OOP healthcare payments could be one of the causal barriers. The high OOP healthcare payments prevent patients from seeking essential healthcare. Furthermore, there is limited evidence on the level of financial risk due to OOP healthcare payments for illness during pregnancy, postpartum, and neonatal periods in rural Ethiopia and such evidence is needed for creating fair health policies [5].

Financial risks are financial catastrophes and impoverishment due to OOP healthcare payments [6]. A household's capacity to pay is the net remaining after expenditure on essential goods (i.e., non-food expenditure) and used as a proxy measure for a household's ability to pay [7]. Globally, each year, it is estimated that more than 150 million individuals from 44 million households face catastrophic healthcare expenditures (CHEs) and that more than 100 million individuals from 25 million households are pushed into extreme poverty due to OOP healthcare payments [8]. Financial risks might force households to cut their basic necessities, and sell assets [6]. Moreover, poor households may not even be able to afford to seek essential healthcare and they remain trapped in a vicious circle of illness and poverty [6, 9].

Previous studies indicated that OOP healthcare payments were high during illness. For example, the OOP healthcare payment for sick postpartum women in Bangladesh was \$261 [10]. OOP healthcare payments accounted for 40% in Chile [11], more than 50% for Indian sick neonates [12], and they were three times higher during hospitalisation among the poorest Indian households [13]. Approximately 4 to 6% of households

in Vietnam faced CHE [14], 2 to 3% in Iran [15], and 2 to 28% in Kenya [5]. Due to high CHE, people would likely forgo the healthcare that they need, as they could not afford it. Possible influencing factors were household economic status, educational status, and occupation of the head of the household [16]. Increasing domestic investments in public healthcare finance can reduce the risks involved in OOP healthcare payments [17]. Besides, incorporating financial risk protection mechanisms into the healthcare system [18], and reforms towards universal health coverage [19], could substantially improve the health status of households.

In Ethiopia, 31–34% of the national healthcare budget (total health expenditure) was financed by OOP healthcare payments (2010/11–2016/17) [9, 20, 21], which is considerably higher than 21% of the global average, 15–20% of the global target, and even higher than 30% of the low-income countries average [21, 22]. Such high OOP healthcare payments for healthcare result in severe financial risks and can be catastrophic and impoverishing for poor households. In 2013, in Ethiopia, it was estimated that 350,000 poverty cases were due to direct OOP medical costs [23]. Approximately 7% of Ethiopian households with children suffered from severe pneumonia. Furthermore, approximately 6% of Ethiopian households with severe diarrhoea were pushed into extreme poverty and poorer and rural households were more likely to be impoverished due to OOP healthcare payments for these services [24]. These findings indicate that OOP healthcare payments are highly linked to financial risks [20].

The Ethiopian government is attempting to remove financial barriers associated with seeking healthcare, reduce catastrophic OOP healthcare payments, and increase utilisation of healthcare services by scaling-up health insurance schemes in the following major ways: community-based health insurance (CBHI) for informal sectors of the economy in urban and rural areas, which now covers over 22.5 million citizens [25]; and social health insurance (SHI) for civil servants and the formal sector, which is currently about to be launched by the government [26]. However, poor mothers and neonates, with a high rate of illness, are still making a considerable

amount of OOP healthcare payments [9] because community-based health insurance schemes are not yet in place in the study area.

Based on these findings, we hypothesized that households faced high CHE and poverty due to healthcare seeking. Secondly, we aimed to elucidate to what extent OOP healthcare payments influenced healthcare utilisation and related coping mechanisms. Therefore, we attempted to fill this knowledge gap and to assess the financial risk of seeking maternal and neonatal healthcare during an illness of pregnancy, postpartum, and neonatal periods in southern Ethiopia.

## Methods and materials

### Study setting and population

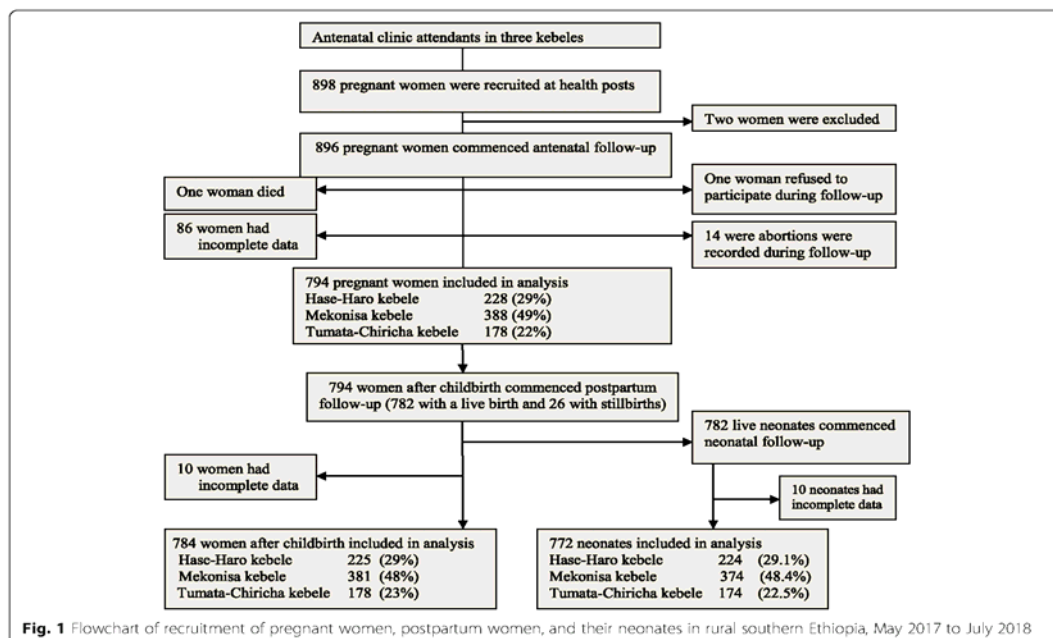
In this study, a population-based cohort study was conducted among 794 pregnant women, 784 postpartum women, and their 772 neonates from 794 rural households to estimate CHE due to illness during pregnancy, postpartum, and neonatal periods. A household was designated as consisting of individuals who lived in the same dwelling and who had common arrangements for basic domestic and/or reproductive activities.

This study was performed in three randomly selected kebeles (i.e., *Mekonisa*, *Hase-Haro*, and *Tumata-Chiricha*) from the *Wonago* district of southern Ethiopia,

which is located 420 km from the capital city of Addis Ababa. The data were collected from May 2017 to July 2018 for 15 months. The study area comprised four health posts and two health centers with a total population of almost 29,000 [27]. In 2013, more than 80% of the Ethiopian population lived in a rural area, 26% of residents earned less than \$1 per day, and 77% of rural women travelled more than 20 km to reach a hospital [28]. Detailed information on the methods, study design, procedure, sample size, and major findings were presented in our previous study [29].

### Sample size and sampling technique

The sample size was determined by Openepi software Version 3.03 ([www.openepi.com](http://www.openepi.com)) for epidemiological studies [29]. This sample size was also used for the economic evaluation. We assumed 15.5% of the incidence of pregnancy-related illness, and a 1.65 relative risk [30] among poor women, compared with rich women (95% confidence level, 80% power, and 1:1 ratio of unexposed to exposed). After adding 10% of non-response, the sample size was estimated to be 898 (Fig. 1). Each participant was visited at home (i.e. every two weeks for pregnant women, eight times for postpartum women up to 42 postpartum days, and six times for their neonates up to the age of 28 days). First, pregnant women were



recruited from health posts attending antenatal care and interviewed about socioeconomic and demographic characteristics. Included participants were those who participated in respective pregnancy-related, postpartum, and neonatal illness study, and identified during scheduled visits. Those study participants who were not easily contacted or those who presented with illness after arranged pregnancy, postpartum and neonatal visit days were excluded.

#### Outcome variables

The primary outcome variables were the catastrophic and/or impoverishing effect of OOP healthcare payments. CHE was dichotomized with a value of 0 or 1 (0 = not facing CHE, and 1 = facing CHE). Impoverishment was also dichotomized with a value of 0 or 1 (0 = not impoverished, 1 = impoverished) [31].

#### Exposure variables

The exposure variables concerned the socioeconomic status of the household. The variables included: (1) predisposing factors: utilisation of healthcare services during illness, household size, and age of pregnant women; (2) enabling factors: socio-demographic characteristics (educational status and occupation of the head of the household, and households' wealth quintiles); and (3) need factors: illness among pregnant women, postpartum women, and neonates. In this study, we used total household expenditure, instead of household income, as consumption is a better proxy for household welfare level in low-income settings [32].

#### Data collection tools and quality assurance

Baseline socio-economic and follow-up data were collected via an interviewer-administered questionnaire during visits to the participants' homes. The questionnaire was adapted from an earlier survey in Ethiopia [33], and the data collection was guided by published techniques and their implementation to analyse health equity using household survey data [31]. The questionnaire was prepared in English, translated into the local *Gedeo* (see Additional file 1.txt) and Amharic languages (see Additional file 2.txt), and then translated back into English (see Additional file 3.txt). A pre-test was conducted in a neighboring *kebele*. Data collectors read the questions aloud and asked the women to indicate whether they had any symptoms of pregnancy-related, postpartum, and neonatal illness; whether they utilised healthcare services; the amount of OOP healthcare payments made by the household, and sources of coping mechanisms concerning OOP healthcare payments. The data collectors were trained women, residents of the selected *kebeles*, and had completed at least grade 10. The

data collectors and supervisors were experienced in data collection and supervision.

#### Patient payment for healthcare

Patient payment for utilisation of healthcare services during maternal and neonatal illness was calculated by summation of the household's *direct medical* and *direct non-medical* OOP healthcare payments. A household's *direct medical* OOP healthcare payment was calculated in terms of direct payment made by households to healthcare providers at the point of receiving healthcare services due to illness. This included registration/card fees, medicines, laboratory tests, etc., for outpatient visits; and for inpatient stays, bed charges at healthcare facilities. *Direct medical* OOP healthcare payment also excluded any prepayment for healthcare services, i.e. taxes or insurance. Household's *direct non-medical* OOP healthcare payment was calculated in terms of payments related to transportation, and daily living payments including accommodation, and food for the accompanying household members or caregivers, and additional expenses for the caregiver during outpatient and inpatient visits [7]. The reference period for outpatient and inpatient payments was one year (12 months). Even though we did not collect on informal ("envelope") payments for healthcare services, there are several problems in Ethiopia, including informal healthcare provision, illicit charging, and corruption [34].

All estimates for annual total household expenditure and OOP healthcare payments were self-reported. Besides being convenient, self-report of these estimates have demonstrated to be effective in capturing household expenditure and OOP healthcare payments. However, there could be over or under-reporting. To avoid over or under-reporting, we used short recall visit time [31].

Both total household and non-food expenditures were used to measure the incidence and intensity of catastrophic payments and their impacts on poverty. Total household expenditure was used to construct the quintiles for households as a direct measure of the living standard of the households. Poverty differences were shown across the quintiles of total household expenditures and between gross and net of healthcare payments. On this basis, the households were classified into five quintiles and were designated from the lowest to the highest quintiles. Financial fairness (equity) was estimated by measuring the relationship between OOP healthcare payments and the ability to pay. A percentage of OOP healthcare payments with total household expenditure by quintile of total household expenditure was estimated to assess the distribution of economic benefits and burdens in society [31].

Total household expenditure was calculated by summation of all expenditures on food and non-food expenditures. It comprised the monetary value of the consumption of home-made products [7] and computed based on 10 different types of household expenditures. For food and supplies, the head of the household was asked, "On average, about how much have you spent in ETB per day?"; for all other expenditure categories, the survey question was phrased, "About how much did you spend?"; for utilities, in ETB per month (i.e., for electricity, water, and telephone service); for goods and utensils, in ETB per year; for education, in ETB per semester (i.e., for children or self); for OOP healthcare payments, in ETB in the last three months as baseline data; for house rent, in ETB per month; for clothes, in ETB per year; for maintenance of bicycles, carts, motorbikes, etc., in ETB per month; for replacements of household appliances, in ETB per month; and for reimbursement of the loan(s), in ETB per month [35]. All expenditures were collected in local currency or Ethiopian ETB and then converted to United States dollars (\$). The average 2017/18 exchange rate of \$1 was equal to 26.11 ETB [36]. In this study, financial risk due to OOP payments for seeking healthcare for maternal and neonatal illness was estimated using the following four indicators of financial risk protection (FRP): incidence of CHE, mean positive catastrophic overshoot, the incidence of impoverishment, and increment of the depth of poverty [31].

To estimate the proportion of households incurring CHE, OOP healthcare payment(s) by each household was divided by total household expenditure per year and reported as a percentage. CHE was defined as OOP healthcare payments that became catastrophic if the OOP healthcare payment exceeded a 10% threshold of total household expenditure or a 40% threshold of non-food expenditure (capacity to pay) [37]. The fraction of households' OOP healthcare payment to total household expenditure (at 10%), or capacity to pay (at 40%)  $\times 100$  [38] was used for estimation of the variability of the financial burden. To derive households' total annual OOP healthcare payments, we normalized expenditures to an annual scale in 12 months, and then summed across categories.

To assess the impoverishing effects of OOP healthcare payments, the incidence of CHE was estimated using poverty headcount. Poverty headcount was estimated by the proportion or ratio of households that incurred catastrophic OOP healthcare payments that exceeded the defined threshold. The intensity of CHE was also assessed using overshoot and using mean positive overshoot [37]. Overshoot was measured using the average percentage of households which incurred catastrophic OOP healthcare payments and exceeded the threshold across the entire sample. Mean positive overshoot was

the average percentage of households which incurred catastrophic OOP healthcare payments and that exceeded the threshold, but only among households that exceed either threshold. The poverty impact was estimated using poverty headcount including gross of and excluding net of OOP healthcare payments [39] and the poverty gap using the poverty line [40].

In this study, Pen's Parade plot was produced to illustrate the magnitude of impoverishment, using plots of two expenditure paradises (i.e., total household expenditure and such expenditure net of OOP healthcare payments), with a cumulative proportion of households ranked according to their total household expenditure [31]. Therefore, impoverishment was analysed based on total household expenditure gross of and net of OOP healthcare payments and the international poverty line, PPP \$1.9  $\approx$  49.6 ETB per capita per day, using the 2015/16 report on poverty and household welfare from Ethiopia [41]. The coping mechanism employed for financial difficulties by households to cover OOP healthcare payment(s) was also analysed (i.e., selling of assets, and borrowing).

#### Statistical analysis

The data were entered in EpiData version 3.1 software (EpiData Association Odense, Denmark). For analysis of financial risks (i.e., catastrophe and impoverishment), three variables were used: OOP healthcare payments, total household expenditure, and non-food expenditure. Our study used the households as the unit of analysis. The OOP healthcare payment was disaggregated by pregnancy-related, postpartum, and neonatal illness. The concentration curve was used to measure inequality in the distribution of total household expenditures, OOP healthcare payments, and utilisation of healthcare services. The concentration curve laid inside and/or outside the per capita total household expenditure curve (Lorenz curve) gross OOP healthcare payments. The farther is the curves from the 45° line of equality, the greater is the inequality [31].

Univariate analysis was conducted using descriptive analysis. Then, bivariate analysis was carried out to analyse the difference between variables. As per the recommendation of Hosmer and Lemeshow, variables with  $P$ -values  $\leq 0.2$  in univariate analysis were used for multivariate analysis [42].  $P$ -values  $\leq 0.05$  were used as cut-off points to determine significant association. Multivariate logistic regression analysis was performed to identify factors associated with CHE. The strength of these associations was quantified using odds ratio (aRR) with corresponding 95% confidence intervals (CI). Data were analysed using SPSS software, version 25 (SPSS Inc. Chicago, IL, U.S.A.), and Automated Development Economics and Poverty Tables (ADePT) software, version

6,06648 developed by World Bank's experts ([www.worldbank.org/adept](http://www.worldbank.org/adept)).

### Result

A total of 896 households of pregnant women were recruited. Of these, 11% (102 of 896 women) had incomplete data and were excluded (i.e., 86 women dropped-out, one died, one refused to participate, and 14 abortions occurred after week 21 and before 28 weeks of gestation). In the analysis, 794 pregnant women, 784 postpartum women, and their 772 neonates were included from 794 households (Fig. 1). The response rate was 89% (794 of 896 women). The average household size among study households was 4.7 persons per household.

### Household characteristics

Table 1 presents the socio-economic characteristics and illness status of the 794 households. From enabling factors, 167 (21%) of heads of households had no formal education. Of the need factors, 93% of pregnant women (735 of 794), 31% of postpartum women (244 of 784), and 48% of neonates (369 of 772) experienced an illness during the study period. However, only 56 households utilised healthcare services (i.e., 6%, 41 of 735 of sick pregnant women; 2%, 5 of 244 of sick postpartum women; and 3%, 10 of 369 of sick neonates). Concerning predisposing factors, 68% (537 of 794) of the total household expenditure was below the poverty line of \$1.9 per day or \$693.5 per year, and 71% (560 of 794) of food expenditure was also below the poverty line of \$1.9 per day.

### Household expenditures

Table 2 presents household expenditures per year. There were more observations below and above the mean (right-skewed) for both total and non-food expenditures. The median total households' expenditure of \$527 (13,760 ETB) per year (IQR = 390: 370,760). The median households' non-food expenditure was \$67 (1749 ETB) per year (IQR = 46: 46, 92), and accounted for 15.7% of households' budget (95%CI: 15.6, 15.8). Households' budget share on food was 84.3% (95%CI: 84.2, 84.4).

### Out-of-pocket (OOP) healthcare payments

There were 109 episodes of out-of-pocket healthcare payment with two episodes per household (i.e., 109 episodes per 56 households). However, the episode of OOP healthcare payments during pregnancy-related illness was 1.2 episodes per household (i.e., 51 episodes per 41 sick pregnant women), 8.2 episodes during postpartum illness (i.e., 41 episodes per five sick women after childbirth), and 1.7 episodes during neonatal illness (i.e., 17 episodes per 10 sick neonates).

The total OOP healthcare payment during illness was \$13,802 (360,370 ETB) per year with median of \$46 (1202 ETB) per household (IQR = 46: 46, 92) (Table 3). However, on average, OOP healthcare payment for direct medical services was \$105.5 and \$21.5 for non-medical expenses. The average OOP healthcare payment during pregnancy-related illness ( $n = 51$ ) was \$95.6 (i.e., \$89.1 for direct medical and \$6.5 for direct non-medical expenses). The average OOP healthcare payment during postpartum illness ( $n = 41$ ) was also \$22.7 (i.e., \$15.4 for direct medical and \$7.3 for direct non-medical expenses). Besides, the average OOP healthcare payment during neonatal illness ( $n = 17$ ) was \$8.9 (i.e., \$1.1 for direct medical and \$7.8 for direct non-medical expenses).

### Per capita healthcare finance across quintiles

Table 3: presents per capita healthcare finance across quintiles of total household expenditure. The median per capita total household expenditure for the lowest, second and third quintile was lower than the total median, \$527 (13,760 ETB), which indicated that more than 40% (343 of 794) of households consumed less than the median. Per capita total household expenditure gross of OOP healthcare payments for the lowest quintile was \$73; while the net of OOP healthcare payment was \$69. The median per capita total household expenditure in the lowest quintile (\$73) was less than half of the total median (\$527). Total median per capita total household expenditure among the lowest quintile was 14% (\$73 of \$527); however, it was 40% in the highest quintile (\$212 of \$527).

The lowest quintile contributed to \$7 OOP healthcare payments, which was less than half that of the highest quintile (\$15). Households in the lowest quintile consumed 0.34 times that of per capita total household expenditure to the highest quintile in respect of gross of (\$73/\$212) and net of (\$69/\$203) of OOP healthcare payments, which indicated that inequity existed in OOP healthcare payments between the lowest and the highest quintiles.

### Out-of-pocket (OOP) healthcare payment share across quintiles

Figure 2 presents the OOP healthcare payments share by quintiles. The financing budget share of OOP healthcare payments to quintiles of per capita total household expenditure or consumption decreased from the lowest quintile to the third quintile. In the lowest quintile, the household's budget share of OOP healthcare payment was 22.4%. On the other hand, it was 18% in the second; 11.5% in the third; 22.2% in the fourth; and 19% in the highest quintile. In general, the overall household's budget share of total OOP healthcare payments across quintiles was 18.6%.

**Table 1** Characteristics of households in rural southern Ethiopia, May 2017 to July 2018

Household's characteristics		Frequency	Percent
Kebele/residence (n = 794)	Mekonisā	388	49
	Hase-Haro	228	29
	Tumata-Chiricha	178	22
Age of pregnant women (n = 794)	15–19	106	13
	20–24	226	29
	25–29	289	36
	30–34	131	17
	35+	42	5
<b>Predisposing factors</b>			
Pre-payment total household expenditure per year in \$ (n = 794)	< \$693.5	537	68
	\$693.5+	257	32
Post-payment total household expenditure per year in \$ (n = 794)	< \$693.5	552	70
	\$693.5+	242	30
Food expenditure per year in \$ (n = 794)	< \$693.5	560	71
	\$693.5+	234	29
Non-food expenditure per year in \$ (n = 794)	< \$693.5	787	99
	\$693.5+	7	1
<b>Utilisation of healthcare services during illness</b>			
Pregnant women (n = 735)	Yes	41	6
	No	694	94
Postpartum women (n = 244)	Yes	5	2
	No	239	98
Neonates (n = 369)	Yes	10	3
	No	359	97
<b>Enabling factors</b>			
Educational status of the head of the household (n = 794)	No education	167	21
	Primary	470	59
	Secondary and above	157	20
Occupation of the head of the household (n = 794)	Agriculture	471	59
	Sales and services	45	6
	Skilled manual	22	3
	Professional/technical/managerial	22	3
	Unskilled manual	159	20
	Others	75	9
<b>Need factor: illness occurrence</b>			
Pregnant women (n = 794)	Yes	735	93
	No	59	7
Postpartum women (n = 784)	Yes	244	31
	No	540	69
Neonates (n = 772)	Yes	369	48
	No	403	52

**Note:** 1 Ethiopian ETB equals 0.0383 dollars (\$1 = ETB 26.11)



**Table 2** Household expenditures per year in southern Ethiopia, 2017/2018 (n = 794)

Expenditures	Mean per household (\$)	Median per household (\$)	Total (\$)
Food and supplies (i.e., food, plates, cups, etc. which were bought, grown or produced, received as wages, received as a gift or loan, or spent on cooking and lighting fuel)	500	419	401,992
Utilities (i.e., electricity, water, telephone, etc)	12	14	9861
Education (i.e., schooling for children or self)	2	0	1383
House rent	7	0	5127
Goods and utensils for household use	8	8	6596
Clothes	32	27	25,578
Maintenance of bicycle(s), carts, motorbike, etc	10	0	8065
Replacements of household appliances (i.e., stove, lanterns, etc.)	13	14	10,227
Reimbursement of loan (\$)	10	0	7848
Pre-healthcare total household expenditure (gross)	593	527	476,677
Post- healthcare total household expenditure (net)	576	503	462,875
Non-food expenditure (i.e., ability to pay)	93	67	74,685
The proportion of expenditure on food to total household expenditure	84%	88%	84%

**Catastrophic healthcare expenditures (CHE)**

Table 4 presents the incidence (headcount) and intensity of CHE (overshoot and mean positive overshoot) at thresholds of total household (non-food) expenditures. At a 10% threshold of total household expenditure, the incidence of CHE was 45.6% (50 of 109 households) (i.e., the proportion of households whose budget share for OOP healthcare payment exceeded the threshold), the overshoot was 10.4%, (i.e., average excess OOP healthcare payment budget share among all of the households), and the mean positive overshoot was 22.8% (i.e., average excess OOP healthcare payment budget share of those households with CHE). However, at a 40% non-food expenditure threshold, the incidence of CHE was 74.4% (81 of 109 households), the overshoot was 202.7%, and the mean positive overshoot was 272.5%.

Table 5 presents the incidence of CHE among poor and rich households. The negative concentration index for CHE showed a greater tendency for the poor to cross the CHE threshold.

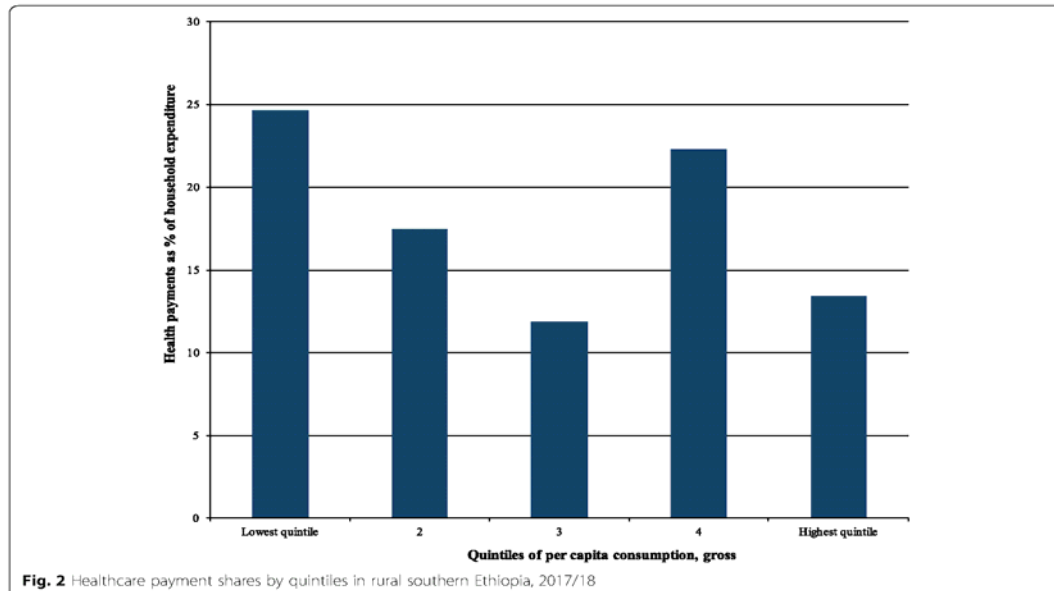
**Coping strategies**

Coping strategies adopted based on the extent of a financial burden on households and thus depend on the burden of maternal and neonatal illness and the rate utilisation of healthcare services. About 13% of households (7 of 56) employed different strategies to cope with financial hardship to cover OOP healthcare payments; including loan or borrowing from family members, 4% (2 of 56 households); loan or borrowing from neighbours, 4% (2 of 56 households); and loan or borrowing from friends with interest, 6% (3 of 56 households).

**Table 3** Per capita healthcare finance across quintiles of total household expenditure in southern Ethiopia, 2017/2018

Quintiles	Per capita annual total household expenditure, (gross of)		Household annual OOP healthcare payments		Per capita annual total household expenditure, (net of)	
	Mean (\$)	Median (\$)	Mean (\$)	Median (\$)	Mean (\$)	Median (\$)
Lowest quintile	82	73	20	7	80	69
Second quintile	83	73	22	8	80	70
Third quintile	89	79	21	8	86	75
Fourth quintile	101	90	22	8	98	86
Highest quintile	239	212	42	15	232	203
Total	593	527	127	46	576	503

**Note:** 1 Ethiopian ETB equals 0.0383 dollars (\$1 = 26.11ETB)



**Impoverishing catastrophic healthcare expenditures**

Table 6 presents the analysis of impoverishment based on expenditure gross of and net of OOP healthcare payments. Approximately 99.6% of households were living below the poverty line after healthcare expenditure. The average deficit or depth of poverty to reach the poverty line was 45.4 Ethiopian Birr per day. Moreover, 91.6% of households were pushed further below the poverty line due to CHE. The increase in poverty due to CHE or the percentage of point change according to the poverty headcount was 0.3 (0.3%) and 0.9 (2%) according to the poverty gap.

The Pen's Parade quintile diagram illustrated the magnitude of impoverishment due to CHE. On the

horizontal axis, every household was arranged from the poorest to richest, while the vertical axis showed the level of OOP healthcare payments per capita. The bold red flat line in the figure was the international poverty line. The two important findings from the plot were that there were extremely poor households living below the poverty line, and there was poor utilisation of healthcare, as the incidence of OOP healthcare payments was low which was indicated in the few red drops. Even if the welfare of households was increasing among currently rich households, the extent and depth of poverty were also increased (Fig. 3).

**Concentration curve**

Fig. 4 A., B., C., and D. present the concentration curves for OOP healthcare payments and utilisation of available healthcare services.

Figure-4. A. shows the concentration curve for OOP healthcare payments. Comprising up to 40% of consumption, the concentration curve of OOP healthcare payments lay outside per capita gross consumption (Lorenz curve). This indicated that the rich households paid more of their total household expenditure for healthcare than did the poor households. However, after 40% of consumption, the concentration curve of OOP healthcare payments was located inside the per capita gross consumption curve. This suggested that the poorer paid more than did the richer for healthcare.

**Table 4** Incidence and intensity of CHE in southern Ethiopia, 2017/2018

Total household expenditure	Threshold budget share			
	10%	15%	25%	40%
CHE headcount	45.6	29.0	17.1	11.5
<b>Overshoot</b>	10.4	8.7	6.5	4.4
<b>Mean positive overshoot</b>	22.8	29.9	38.2	38.2
<b>Non-food expenditure</b>				
CHE headcount	-	-	84.4	74.4
<b>Overshoot</b>	-	-	214.7	202.7
<b>Mean positive overshoot</b>	-	-	254.4	272.5

**Table 5** Incidence of CHE among poor and rich households in southern Ethiopia, 2017/2018

Concentration indexes for:	Threshold budget share			
	10%	15%	25%	40%
CHE (relative to total household expenditure)	-0.114	-0.099	-0.078	-0.052
CHE (relative to non-food expenditure)	-	-	-0.264	-0.275

Figure-4. B. presents the concentration curve for the utilisation of healthcare services during pregnancy-related illness almost all lay inside the per capita gross consumption curve. This indicated that the poorer households paid more than did the richer for utilisation of healthcare services during pregnancy-related illness.

Figure-4. C. shows the concentration curve for the utilisation of healthcare services during the postpartum illness with an abnormal peak just after the 65% mark of the population ranked from the poorest to richer, and was located almost outside the per capita gross consumption curve. This suggested that the richer households paid more than did the poorer for utilisation of healthcare services during postpartum illness.

Figure-4. D. presents the concentration curve for the utilisation of healthcare services during neonatal illness with an abnormal peak just after the 20% mark of the population ranked from poorest to richer, and almost all of the concentration curve of the utilisation of healthcare services during neonatal illness was located inside the per capita gross consumption curve. This suggested that the poorer households paid more than did the richer for utilisation of healthcare services during neonatal illness.

#### Determinants of catastrophic healthcare expenditures

Table 7 shows the determinants of CHE. Households with neonatal illness were three times more likely to experience CHE than those households without neonatal illness (aRR: 2.56, 95%CI: 1.02, 6.44).

#### Discussion

This study indicated that a significant proportion of the households experienced CHE and were forced below the poverty line due to OOP healthcare payments for pregnancy-related, postpartum, and neonatal illness among rural households in southern Ethiopia. This is evidenced that unless the OOP healthcare payments fall to

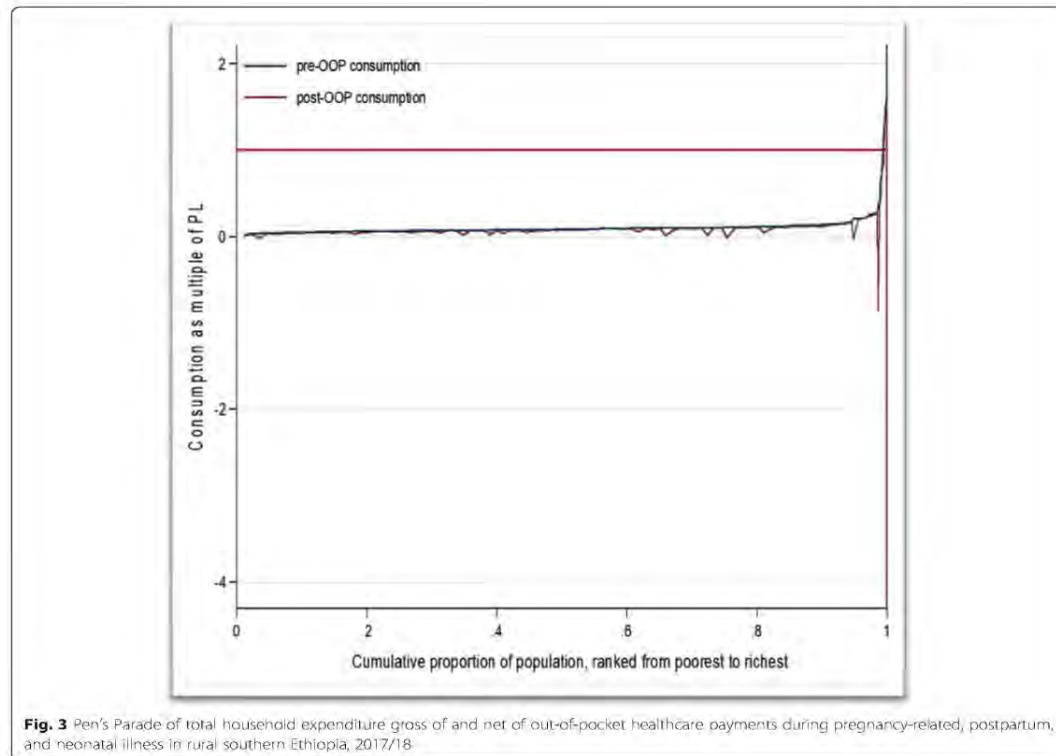
15–20% of total health expenditures, the incidence of financial catastrophe and impoverishment could not fall to negligible levels [22].

Moreover, households were very poor and very few households utilised available healthcare services during illness. CHE was also more concentrated among three-fourth of the poorest than the richest households. It was further found that socioeconomic characteristics of the households contributed to CHE. Besides, annually, approximately 2% of households fell into poverty due to CHE; this corresponds to the economic impoverishment of nearly 22,000 people in the *Gedeo* zone, Ethiopia. Such impoverishment due to OOP healthcare payments, in turn, has a major impact on household health and affects the utilisation of healthcare services. Consequently, because of the high risk of financial catastrophe and impoverishment, in turn, achieving universal healthcare coverage could be impossible.

The need for utilisation healthcare services might be higher than the actual utilisation of healthcare services. However, in this study, there were a low number of households with OOP healthcare payments and there were also a low number of households utilising available healthcare services. Those households in the richest quintile sought more healthcare services and had more OOP healthcare payments than those households in the poorest quintile. This was evidenced by OOP healthcare payments resulting in an additional 2% of households falling into poverty. This finding was consistent with other studies from Zimbabwe [43], as poverty was associated with low utilisation of healthcare services. The poorest households suffered from high OOP healthcare payments, which resulted in a higher incidence of CHE. Although the richest households tended to have higher OOP healthcare payments, the capacity to pay for the richest households was also higher than that of the poorest households. In fact, given that some of the poorest households may not seek healthcare due to high OOP

**Table 6** Analysis of impoverishment based on total household expenditure gross of and net of out-of-pocket healthcare payment (poverty line = PPP \$1.9 ≈ 49.6 ETB) in southern Ethiopia, 2017/2018

Analysis of Impoverishment	Gross of OOP healthcare payment	Net of OOP healthcare payment
Poverty headcount (%)	99.3	99.6
Poverty gap (ETB)	44.5	45.4
Normalized poverty gap (% of the poverty line)	89.7	91.6
Normalized mean positive poverty gap (% of the poverty line)	90.4	92.0



healthcare payments, the financial burden could be even higher for the poorest if this factor was accounted for. Therefore, developing a viable removal or reduction of financial risk for the poorest households is critical.

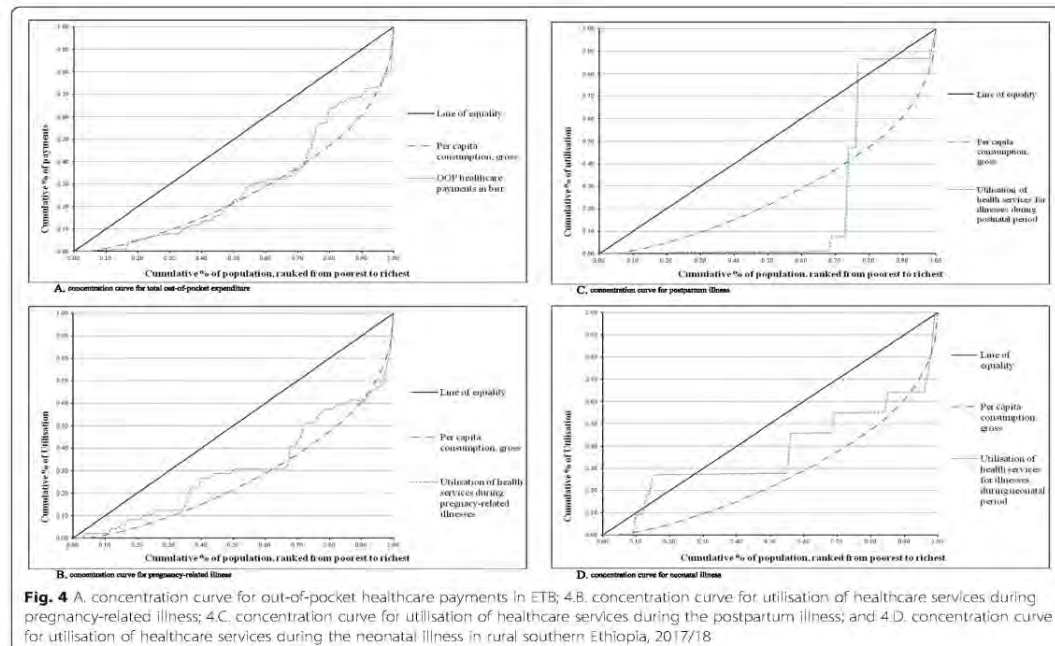
Based on the findings of this study, the lack of financial health protection in the study area may indicate that the financial burden is heavier among the poorest households and has implications for the consumption of essential basic necessities. This might be one of the reasons why poor households allocated a greater share of their household budget to food compared to rich households [44].

Heavy reliance on OOP healthcare payments posed a financial burden on households and lead to different types of coping strategies to be adopted to cover healthcare payments for maternal and neonatal illness. In our study, coping strategies adopted to meet OOP healthcare payments are consistent with a study from rural Bangladesh [45].

Our findings of CHE based on different thresholds were comparable with other studies reported from Rwanda, [46], Kenya [47], Ghana [48], and Uganda [49]. Therefore, OOP healthcare payment impoverishes households and limits the choice of seeking healthcare services during illness.

However, results from this study were not consistent with a previous study in Ethiopia [50], which reported that 24% of households faced financial catastrophe due to OOP healthcare payments, and such catastrophe pushed 5.8% of households into poverty. This difference could be due to that the study participants were with chronic illness, while we were following acute illness among mothers and neonates. Our findings in this regard are similar, implying that 6% of total households faced financial catastrophe and this was three times higher among households whose food expenditure was below the poverty line [51].

The findings of this study also indicated that those poorer households experienced CHE more often. Some



studies from Ethiopia [50], Mongolia [51], and Swaziland [44] reported that *households* who were *poor* became even *poorer* after CHE. However, estimation techniques of OOP healthcare payments differed in many studies. For instance, the household's socioeconomic status was determined using the household's total expenditure or asset index. Choosing asset quintiles to determine the wealth quintiles in this study was supported by a study from Asia [52].

This study was a population-based study as population-based design and population-based household data are useful to provide empirical literature in assessing patterns and extent of financial risk, in tackling the poverty impact of OOP healthcare payments, and in reducing the financial burden of incurring direct medical and non-medical expenditures for healthcare [53]. A recent *population-based cohort study* in the Democratic Republic of Congo [53] demonstrated that a population-based design can yield disaggregated data on the medical and non-medical expenditures, and may also improve understanding of the nature of the economic and social hardships experienced by households at a community-level. Besides, in areas where the provision of public services requires effective policing towards improved health equity and service coverage, and in areas in which

multiple wealth-related disparities were common, strong primary evidence from population-based studies is essential to inform technical and political decision-makers.

This study possessed certain limitations. The distribution of OOP healthcare payments was heavily skewed rightwards as there were many small values, a few very large ones, and many zero values. As a consequence of this departure from the normal distribution, the frequency with which a conventional confidence interval for the OOP healthcare payment estimate would not capture the true population parameter and may be greater or might be higher than the probability stated for the confidence interval. Besides, our study did not identify those who forwent utilisation healthcare services since they could not afford healthcare payments and therefore did not incur OOP healthcare payments. Moreover, household annual total household expenditure and OOP healthcare payments were self-reported; and thus there may be over or under-reporting. The findings of this study could also be exaggerated. This was because the OOP healthcare payments used in the analysis were the sum of the three categories (i.e., pregnant women, postpartum women, and neonates), the summation of all repeated visits, and we reported it on an annual basis. Furthermore, all expenditures and all

**Table 7** Determinants of catastrophic healthcare expenditure in rural southern Ethiopia, May 2017 to July 2018

Household's characteristics		Catastrophic headcount											
		At a 10% threshold of total household expenditure						At a 40% threshold of non-food expenditure					
		Yes	No	Crude relative risk (95.0%CI)	p-value	Adjusted relative risk (95.0%CI)	p-value	Yes	No	Crude relative risk (95.0%CI)	p-value	Adjusted relative risk (95.0%CI)	p-value
<b>Utilisation of healthcare services during:</b>													
Pregnancy-related illness (41 of 735)	No	46	53	1.30 (0.35, 4.90)	0.696	–	–	74	25	1.27 (0.31, 5.28)	0.744	–	–
	Yes	4	6	1.0	–	–	–	7	3	1.0	–	–	–
Postpartum illness (5 of 244)	No	45	9	–	–	–	–	76	28	–	–	–	–
	Yes	4	0	–	–	–	–	4	0	–	–	–	–
Neonatal illness (10 of 369)	No	43	58	–	–	–	–	73	28	–	–	–	–
	Yes	2	0	–	–	–	–	2	0	–	–	–	–
<b>Enabling factors</b>													
Educational status of the head of the household	No education	8	7	2.29 (0.63, 8.32)	0.210	–	–	11	4	1.38 (0.34, 5.56)	0.655	–	–
	Primary	33	34	1.94 (0.76, 4.93)	0.163	–	–	52	15	1.73 (0.65, 4.64)	0.274	–	–
	Secondary and above	9	18	1.0	–	–	–	18	9	1.0	–	–	–
Occupation of the head of the household	Agriculture	30	38	0.34 (0.08, 1.42)	0.139	–	–	57	11	–	–	–	–
	Sales and services	4	2	0.86 (0.10, 7.51)	0.889	–	–	5	1	–	–	–	–
	Skilled manual	1	2	0.21 (0.01, 3.37)	0.273	–	–	3	0	–	–	–	–
	Professional/technical/managerial	1	4	0.11 (0.01, 1.41)	0.089	–	–	2	3	–	–	–	–
	Unskilled manual	7	10	0.30 (0.06, 1.58)	0.156	–	–	7	10	–	–	–	–
	Others	7	3	1.0	–	–	–	7	3	–	–	–	–
<b>Illness among:</b>													
Pregnant women (735 of 794)	No	5	3	2.07 (0.47, 9.15)	0.335	–	–	8	0	–	–	–	–
	Yes	45	56	1.0	–	–	–	73	28	–	–	–	–
Postpartum women (244 of 784)	No	31	36	1.10 (0.50, 2.40)	0.811	–	–	50	17	1.08 (0.45, 2.61)	0.867	–	–
	Yes	18	23	1.0	–	–	–	30	11	1.0	–	–	–
Neonates (369 of 772)	No	35	39	1.71 (0.70, 4.16)	0.241	–	–	58	16	2.56 (1.02, 6.44)	0.046	2.56 (1.02, 6.44)*	0.046
	Yes	10	19	1.0	–	–	–	17	12	1.0	–	1.0	–

\*Adjusted for postpartum and neonatal illness, and utilisation of healthcare services for pregnancy-related illness, and educational status of head of the household

OOP healthcare payments from households may not be covered within the questionnaire. This study also focused only on OOP healthcare payments, and it could not measure the impact of opportunity payments, such as income losses during illness, socioeconomic shocks or death. Therefore, the findings from this study should be interpreted with care. A loss to follow-up of study participants include those who were not easily contacted or

those who presented with illness after the defined time frame for postpartum and neonatal periods, and may have introduced a selection bias.

However, this study also possessed some key strengths. This study was one of the very few population-based cohort studies to investigate illness incidence or period prevalence with actual OOP healthcare payments. This study also seems to be the first of its kind of analysis of

OOP healthcare payments in Ethiopia using a dataset that brings a comprehensive understanding of the three categories. Given that our study was conducted in rural areas, in analysis, household expenditure or consumption data were used instead of income data. This was because formal employment was less common, many households had multiple and/or continually changing sources of income, and home production was more widespread. To keep the validity of the data collection on income and expenditure, a standard questionnaire was used which was commonly employed at the national level and beyond, and the data collection process was a direct measure at the household level. Recall periods also differed for different types of goods. For the goods that were purchased infrequently, we used a sufficiently long period, so that the consumption during the period was representative of the reference period (i.e., in a year). We also used a sufficiently short period for the goods that were purchased and consumed frequently, so that households may remember expenditures and consumption with reasonable accuracy. As a cross-check, household income was also compared with household expenditure aggregates. To maintain the balance of expenditure data, aggregating different components of expenditures was done, and a common reference period was established for all items, e.g., a year.

### Conclusions

This study demonstrated that health inequity in the household's budget share of total OOP healthcare payments in southern Ethiopia was high. Besides, utilisation of maternal and neonatal healthcare services very low and seeking such healthcare poses a substantial financial risk during illness among rural households. Both catastrophe and impoverishment due to OOP healthcare payments were high, and their proportion to total household expenditure would alert policymakers to take commensurate action. All differences in OOP healthcare payments highlighted the heavier burden borne by the poorest households.

Therefore, the issue of health inequity should be considered when setting priorities to address the lack of fairness in maternal and neonatal health. Health inequities should be reduced by using mixed government policy action on the social determinants of health: including improvement of schooling, an increment of employment, and improvement of socioeconomic status of the households at least in the study area. The health policy implications of this study include: the Ministry of health should intensify the actions to tackle the root causes of ill-health and health inequities, and should continue increasing advocacy to provide essential healthcare services to women and neonates.

To achieve the goal of universal healthcare coverage, mothers and neonates have to get access to prepayment and financial risk pooling mechanisms. These interventions should target the poorest households, particularly in rural areas, in the following ways: reduce reliance on OOP healthcare payments using payments made in advance of illness to treat sick mothers and neonates, and introduce prepayment schemes to cover payments for transportation and subsistence, such as transportation vouchers and conditional cash transfer during an illness of pregnancy, postpartum, and neonatal periods. Financial risk should be pooled in some way and used to fund healthcare services for every mother and neonate who is covered, find alternative sources of financing to exempt or remove all user fees; and make health insurance available.

### Supplementary information

**Supplementary information** accompanies this paper at <https://doi.org/10.1186/s12939-020-01183-7>.

**Additional file 1.**

**Additional file 2.**

**Additional file 3.**

### Abbreviations

ADePT: Automated development economics and poverty tables; CBHI: Community-based health insurance; CHE: Catastrophic health expenditure; CI: Confidence Interval; ETB: Ethiopian Birr; FRP: Financial risk protection; LMICs: Low and middle-income countries; MPO: Mean positive overshoot; OOP: Out-of-pocket; PPP: Purchasing power parity; SHI: Social health insurance; SPSS: Statistical package for social sciences; \$: United States dollars.

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### Authors' contributions

MT was involved in the conception, design, methods, data collection, analysis, interpretation, and drafting of the manuscript. EL, KA, and BL led the conceptualisation, methodology, and project administration, and supervised the study, analysed the data, interpreted the results, and edited the manuscript. All authors performed a critical review of the manuscript for important intellectual content, coordinated the overall preparation of the manuscript, and read and approved the final manuscript.

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### Availability of data and materials

The data for this paper are available at <https://osf.io/pnj9/>.

### Ethics approval and consent to participate

This study was approved by the Institutional Ethical Review Board at Hawassa University, College of Medicine and Health Sciences (RB/100/08), and by the Regional Committees for Medical and Health Research Ethics (REC) of western Norway (2016/1626/REK vest). Written permission was obtained from the Gedeo Zone Health Department and the Wonago district (Werek) health office. Written informed consent was obtained from each woman or mother after she had received an explanation of the purpose of

the study. The privacy, anonymity, and confidentiality of study participants were maintained, if a woman or neonate was found to have an illness during pregnancy, postpartum, or neonatal period, the data collectors attempted to link the patient with health extension workers in the *kebele*.

#### Consent for publication

No individual data or comments are contained in this paper.

#### Competing interests

The authors declare that they have no competing interests.

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Appendix III: Questionnaires for Paper III

**Form 8: Total health and non-health expenditures of households**

Household characteristics	
House ID	[____/____/____/____/____]
ID	2. Woman
Kebele/village (Name)	1) Mekonisa    2) Tumata chiricha    3)Hase haro
Sub-kebele	
Date interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview: 1. Completed    2. No mother at home    3. No all family at home    4. Another appointment    5. Refused	

Section 1. Household expenditures on non-health consumptions [This section is only necessary to ask once]			
No.	Questions and Filters	Coding Categories	SKIP
	On average how much did your household spend on the following items?		
901.	Food and supplies (e.g. plates, cups, etc.)		
A	How much did your household spend to buy food? (Cereals, teff, oil, salt, etc...)	.....birr/ day	
	Did you consume food that was grown or produced by the household?	0. No    1. yes	If no skip to b
	If yes, how much would it cost to buy the quantity of food that was grown or produced?	.....birr/day	
B	Did you consume food that was received as wages in kind for work?	0. No    1. yes	If no skip to c
	If yes, how much would it cost to buy the quantity of food that was received as wages in kind for work?	.....birr/day	
C	Did you consume food that was received as a gift or loan?	0. No    1. yes	If no skip to d
	If yes, how much would it cost to buy the quantity of food that was received as a gift or loan?	.....birr/day	
D	Did you give away food outside of the household?	0. No    1. yes	If no skip to e
	If yes, how much would it cost to buy the quantity of food that was given away?	.....birr/day	
E	About how much money does your household spend on cooking and lighting Fuel?	.....birr/day	
	Total expenditure on food and supplies	.....birr/ day	
902.	Utilities (electricity, water , telephone)	.....birr /month	
903.	Education (School for children or self)	.....birr/ term (4 months)	
904.	House rent	.....birr/ month	
905.	Health care (for the household)	...birr in the last three months	
906.	Goods and utensils for the household use	.....birr /year	
907.	Clothes	.....birr /year	
908.	Maintenance of bicycle, cart, motorbike	.....birr/ month	
909.	Replacements of household appliances (stove, lanterns, etc.)	.....birr/ month	
910.	Reimbursement of loan (describe)	.....birr/ month	
911.	Others (describe)	.....birr / month	
912.	Have you received any in-kind food item as a gift from relatives or others during the last 3 months?	0. No    1. Yes	
913.	What is the total annual income for the head of your household (average)?	.....Birr	
914.	What is the total annual income for all the members of your household (on average)?	.....Birr	

Thank you!!!

**Form 9: Total health and non-health expenditures of households**

Household characteristics	
House ID	[____/____/____/____/____/____/____/____/____/____]
ID	2. Woman 3. Single 4. If twins, to the second child 5. If triplet, to the third child
Kebele/village (Name)	1) Mekonisa    2) Tumata chiricha    3)Hase haro
Sub-kebele	
Date interview	Date.....
Interviewer name and signature.....	Supervisor name and signature.....
Data clerk name and signature.....	
Result of the interview: 1. Completed    2. No mother at home    3. No all family at home    4. Another appointment    5. Refused	
Ill during? 1) ANC follow-up    2) delivery    3) postnatal period    4) Neonatal period	

In the last 2 weeks, for you/your child's illness, where did you get the treatment?

1. Government health facility
2. Private health facility

Section 2. In the last 2 weeks, Out-patient care expenditures			
No.	Questions and Filters	Coding Categories	SKIP
915.	How many times //have you//has your child// visited a health facility for out-patient care due to any illness since your child was born?	.....	
	For the last out-patient visit(clinics or OPD in hospitals): How much did you spend on out-patient care for treatment of the illness for//you//your// child?		
916.	Drug	.....Birr	
917.	Investigation/tests	.....Birr	
918.	Consultation fee/card	.....Birr	
919.	Transport to and From health facility	.....Birr	
920.	Extra food cost (any special food bought for the infant, for example, any milk or other food, fluid, and food bought for caregivers who accompanied the infant to the treatment provider)	.....Birr	
921.	Additional expenses for a caregiver	.....Birr	
922.	Wages lost	.....Birr	
923.	Traditional healer	.....Birr	
924.	Others (describe)	.....Birr	
925.	Total expenditure	.....Birr	
926.	For the last out-patient visit (clinics or OPD in hospitals): How much time did you spend on out-patient care for treatment of the illness for //you//your// child? (This includes time travelling back and forth and time spent at the facility)	.....hours	
Section 3. Expenditure coping mechanism			
927.	Did you loan to cover your expense?	0. No    1. Yes	If no, SKIP to 932
928.	How much? (Birr)	.....	
929.	From whom did you loan?	1. Family 2. Neighbour/friend 99. Other (mention)	
930.	Does it have any interest?	0- No    1.Yes	If no, SKIP to 932
931.	How much? (Birr)		
932.	If no in 927, 930, did you sell your property to get treatment?	0. No    1. Yes	If No, SKIP to 934
933.	What type?	1. Land 2. Domestic animals 3. Vehicle, cart, etc 4. Household property 99. Other (mention)	

Thank you!!!

Section 4. In the last 2 weeks, In-patient care expenditures			
No.	Questions and Filters	Coding Categories	SKIP
934.	How many times //have you//has your child// been hospitalised?	.....	
For the last hospitalization, how much did you spend on each of the following items during the total stay?			
935.	Admission fee	.....Birr	
936.	Hospital bed	.....Birr	
937.	Drug	.....Birr	
938.	Investigation/tests	.....Birr	
939.	Food (any special food bought for the infant, for example, any milk or other food, fluid and food bought for caregivers who accompanied the infant to the treatment provider)		
940.	Transport to and From health facility	.....Birr	
941.	Wages lost	.....Birr	
942.	Additional expenses for a caregiver	.....Birr	
943.	Others (describe)	.....Birr	
944.	Total expenditure	.....Birr	
For each of the in-patient visits (clinics or OPD in hospitals): How much time did you spend on in-patient care for treatment of the illness for //you//your// child?			
945.	Hours spent travelling:	.....hours	
946.	Days spent in hospital:	.....days	
Section 5. Expenditure coping mechanism			
947.	Did you loan to cover your expense?	0. No    1. Yes	If no, SKIP to 952
948.	How much? (Birr)		
949.	From whom did you loan?	1. Family 2. Neighbour/friend 99. Other (mention)	
950.	Does it have any interest?	0- No    1. Yes	If no, SKIP to 952
951.	How much? (Birr)		
952.	If no in 947, 952, did you sell your property to get treatment?	0. No    1. Yes	If No, SKIP 953
953.	What type?	1. Land 2. Domestic animals 3. Vehicle, cart, etc 4. Household property 99. Other (mention)	

Thank you!!!

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## Supplementary information III: for Paper III

### Paper III. Definition

Financial risks are financial catastrophes and impoverishment due to OOP healthcare payments.

A household's *direct medical* OOP healthcare payment was calculated in terms of direct payment made by households to healthcare providers at the point of receiving healthcare services due to illness.

Catastrophic healthcare expenditure was defined as OOP healthcare payments that became catastrophic if the OOP healthcare payment exceeded a 10% threshold of total household expenditure or a 40% threshold of non-food expenditure (capacity to pay).

## Appendix IV: Ethical Approvals



**Region:**  
REC Western Norway

**our date:**  
11.11.2016  
**your date:**  
20.09.2016

**reference:**  
2016/1626/REK vest

Bernt Lindtjørn  
University of Bergen

**2016/1626 Maternal and Neonatal Illness, Health Services Utilisation, and Household Out-Of-Pocket Expenditure in Rural Ethiopia: A community-based prospective cohort study**

**Institution Responsible for the Research:** University of Bergen  
**Project manager:** Bernt Lindtjørn

With reference to your application, the Regional Committee for Medical and Health Research Ethics (REC Western Norway) reviewed the application in the meeting 27.October 2016, pursuant to The Health Research Act § 10.

**Project summary**

*The maternal and neonatal illness and death rates are still high in Ethiopia. Unfortunately, the decline in disease burden such as severe sickness and death among these two groups is very slow. There are very few studies that have investigated the incidence of diseases among these groups, how they seek healthcare, and how much it costs. The objective is to measure the incidence of maternal and neonatal illnesses, to assess the use of health services, and to measure the household out-of-pocket expenditures. This study will be carried out using a community-based cohort design in the Gedeo Zone in South Ethiopia. We will follow 1354 expectant women and their newborns. We will record illnesses, use of health services, and household expenditures. The relevance of the study is to provide evidence for strategies to reduce the incidence of severe illnesses, and to improve the use of health services.*

**Ethical review**

The research project has been assessed by the institutional review board at Hawassa University, Ethiopia.

*Responsible conduct*

The Committee emphasizes that the research project includes measures to care for and protect participants: «In case mother or newborn child is ill, the project workers will refer them to the nearest appropriate health facility. The chain of referral will depend on the severity of illness and will include options such as health post, and nearby health centre and the hospital which is located about 20 km from the study area. If needed, the project personnel will assist the mothers and their newborns with such transportation.»

According to the protocol «The structured questionnaires will be mainly adapted from monitoring birth preparedness and complication readiness, tools, and indicators for maternal and newborn health.» The Committee has no objections to the research questions, the purpose of the project or the proposed standardized questionnaires. The Committee has however some concerns regarding the context of using the questionnaire Postpartum Depression Screening Scale (PDSS). This questionnaire contains particularly sensitive issues/questions. It is unclear to the Committee why the study includes this questionnaire in this

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Tverrflyøy Nord, 2 etasje, Rom  
281. Haukelandsveien 28

**Telefon:** 55975000  
**E-post:** rek-vest@uib.no  
**Web:** <http://helseforskning.etikkom.no/>

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vest og ikke til enkelte personer

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vest, not to individual staff

context, and we are concerned that the study has a limited focus on the negative aspects of pregnancy/motherhood, i.e. «*I felt a failure as a mother*», «*I began to think I'd be better off dead*», «*I felt I was losing my mind*». However, the Committee accepts the use of the proposed questionnaire, but presumes that the researchers are cautious in the process of obtaining/collecting such data.

#### *Information sheet and consent form*

- The following sentence must be deleted: «*There are no direct, embarrassing or sensitive questions*». Some of the questions are sensitive. Thus, the sheet must clearly inform that the study includes questions to assess postpartum depression.
- In the section «*risk and benefits*», the participants must be informed about the proposed measures for follow-up when required (plan for referral, assistance, including transportation).
- The women must be informed about how much time they will spend participating in the study.

#### *Data processing and confidentiality*

The Committee presumes that the data is anonymized by project end date 30.09.2018.

#### **Condition**

- The information sheet and consent form must be audited according to the remarks and must be sent to REC.

#### **Decision**

*REC Western Norway approves the project in accordance with the submitted application as long as the condition is met.*

#### *Final Report and Amendments*

The approval is based on the grounds that the project is implemented as described in the application and the protocol, as well as the guidelines stated in the Health Research Act. If amendments need to be made to the study, the project manager is required to submit these amendments for approval by REC via the amendment form. The Project Manager must submit a final report to the REC Western Norway no later than 31.03.2019, according to Health Research Act § 12.

#### *Appeal*

The decision of the committee may be appealed to the National Committee for Research Ethics in Norway. The appeal should be sent to the Regional Committee for Research Ethics in Norway, West. The deadline for appeals is three weeks from the date on which you receive this letter.

Sincerely yours

Ansgar Berg  
Prof. Dr.med  
Chairman

Camilla Gjerstad  
Committee Secretary

copy: postmottak@helse-bergen.no



ሀዋሳ ዩኒቨርሲቲ  
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የምርምር ስነ-ምግባር ገምጋሚ  
ቦርድ



**HAWASSA UNIVERSITY**  
COLLEGE OF MEDICINE AND  
HEALTH SCIENCES  
Institutional Review Board

Ref. No: IRB/100/08

Date: 09/09/2016

Name of Researcher(s): *Moges Tadesse Borde, Bernt Lindtjorn, Eskindir Loha*

Topic of Proposal: *Maternal and neonatal illness, health service utilization, and household out-of-pocket expenditure in rural Ethiopia: A community-based prospective cohort study*

Dear researcher(s),

The Institutional Review Board (IRB) at the College of Medicine and Health Sciences of Hawassa University has reviewed the aforementioned research protocol with special emphasis on the following points:

1. Are all principles considered?
  - 1.1. Respect for persons: Yes  No
  - 1.2. Beneficence: Yes  No
  - 1.3. Justice: Yes  No
2. Are the objectives of the study ethically achievable? Yes  No
3. Are the proposed research methods ethically sound? Yes  No

Based on the aforementioned ethical assessment, the IRB has:

- A. Approved the proposal for implementation
- B. Conditionally Approved
- C. Not Approved

Yours faithfully,

Ayalew Astatkie (PhD),  
Institutional Review Board Chairperson.



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✉ 1560 Hawassa



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Southern Nations Nationalities and People's  
Regional Government Gedeo Zone Health Department

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Date

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**ጉዳዩ:- የትብብር ደብዳቤ ስለመስጠት ይሆናል፤**

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household out-of pocket expenditure in rural Ethiopia A community based  
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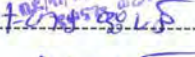
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South Nations Nationalities and People's Region  
Wonago Woreda Health Office



ቁጥር 2/1650/2960  
ቀን 6/3/2009

ሰ-----ቀበሌ ስ/ደ/ቤት

**ጉዳይ:-ትብብርን ደመሰከታል**

ከሳይ በርዕሱ ለመገንጠጥ ስንደተሞክረዉ ስቶ ሞገስ ታደሴ የተባሉ ገንብብ በዘሞላ የኒቨርሽቲ ከፍተኛ ደረጃ ትምህርታቸዉን በመከታተል ሳይ ያሉ መሆናቸዉን ስየሰገድን ስሁን ግን የመመሪያ ጥናታቸዉን ነ/ኩር ስንቸቸ ና ከመሰዱ 42 ቀን በታች የሆናቸዉን ስናቸቸንና ሰብሳቢ ስዳናት ሳይ በቀበሌዎ ሰጠ ዓመት ያህል ጥናት ስንደደድር በትብብር ስንደታደር ስናሳስባለን ::

አንድም እናት በወለድ ምክንያት መሞት የለባትም!!!

ዓለገጽ  
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የዳኅን ስ-ጠይ ነገረ



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የኢትዮጵያን ሀዳሴ እውን አናደርጋለን!!!

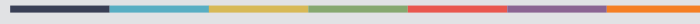
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