BIRTH PREPAREDNESS, COMPLICATION READINESS, NEONATAL CARE PRACTICES AND THEIR EFFECT ON NEONATAL HEALTH STATUS IN JIMMA ZONE, SOUTHWEST ETHIOPIA

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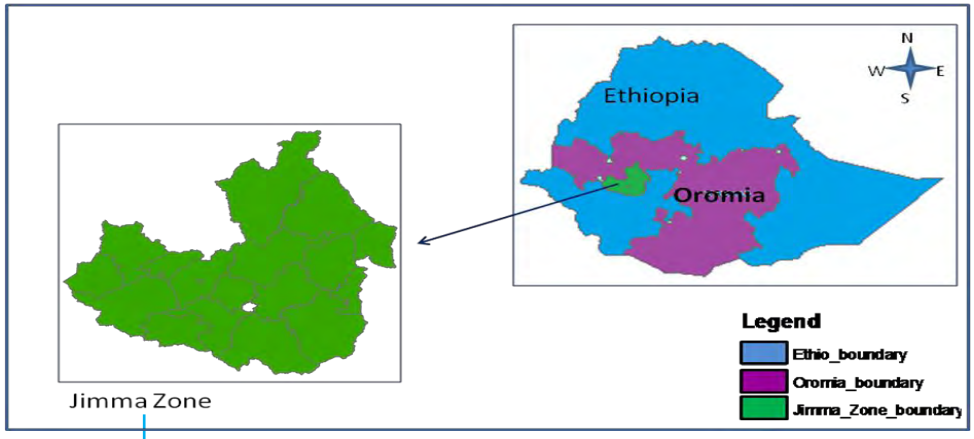

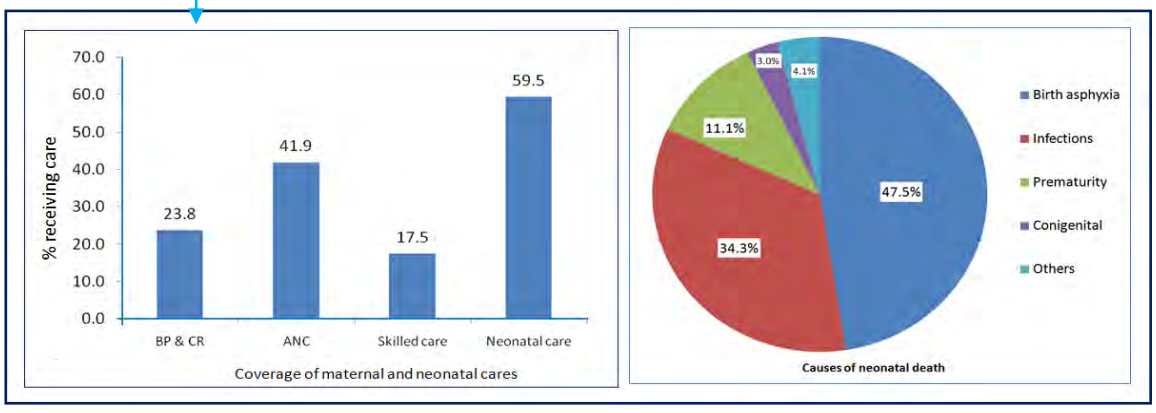

DISSERTATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD) IN PUBLIC HEALTH, ADDIS ABABA UNIVERSITY, ETHIOPIA

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DEDICATION

This dissertation is dedicated to mothers and neonates, who lost their lives because of problems related to pregnancy and childbirth.

LIST OF ORIGINAL PAPERS

This dissertation is primarily based on the following five papers, one systematic review with meta-analysis and four papers from the primary data, which are referred to in the text by their Roman numerals.

I. Tura G, Fantahun M, Worku A. The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. *BMC Pregnancy and Childbirth* 2013; 13:18. doi:10.1186/1471-2393-13-18.

II. Tura G, Fantahun M, Worku A. Factors affecting birth preparedness and complication readiness in Jimma Zone, Southwest Ethiopia: a multilevel analysis. *Pan African Medical Journal* 2014; 19:272. doi:10.11604/pamj.2014.19.272.424.

III. Tura G, Fantahun M, Worku A. The effect of birth preparedness and complication readiness on skilled care use: a prospective follow-up study in Southwest Ethiopia. *Reproductive Health* 2014; 11:60. Doi:10.1186/1742-4755-11-60.

IV. Tura G, Fantahun M, Worku A. Neonatal care practice and affecting factors in Southwest Ethiopia: a multilevel linear regression analysis. *(Under review, BMC International Health and Human Rights)*

V. Tura G, Fantahun M, Worku A. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: a multilevel analysis of prospective follow up study. PLoS ONE 9(9): e107184. doi:10.1371/journal.pone.0107184.

ACRONYMS AND ABBREVIATIONS

ANC	Antenatal Care
BCG	Bacillus Calamite Gurnee
BEmOC	Basic Emergency Obstetric care
BP	Birth Preparedness
CEmOC	Comprehensive Emergency Obstetric Care
CI	Confidence Interval
CR	Complication Readiness
CS	Cesarean Section
CSA	Central Statistics Agency
DHS	Demographic and Health Survey
EDHS	Ethiopian Demographic and Health Survey
FGAE	Family Guidance Association of Ethiopia
GA	Gestational Age
GO	Governmental Organization
HEW	Health Extension Worker
ICC	Intra-class Correlation Coefficient
IDI	In-Depth Interview
IMNCI	Integrated Management of Neonatal and Childhood Illnesses
IRB	Institutional Review Board
LBs	Live Births
MDG	Millennium Development Goal
MMR	Maternal Mortality Ratio
MOH	Ministry of Health
MPH	Masters of Public Health
NGO	Non-Governmental Organization
NMR	Neonatal Mortality Rate
NNM	Neonatal Mortality
OR	Odds Ratio
PCA	Principal Component Analysis
REC	Review and Ethics Committee
SD	Standard Deviation
SGA	Small for Gestation Age
SPSS	Statistical Package for Social Sciences
SVD	Spontaneous Vaginal delivery
TBA	Traditional Birth Attendant
TTBA	Trained Traditional Birth Attendant
UNDP	United Nations‘ Development Programme
UNICEF	United Nation‘s Children Fund
WHO	World Health Organization

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ABSTRACT

Background

In spite of global efforts for many decades, saving the lives and improving the wellbeing of neonates have been global challenges. Recent estimate shows that about 3 million neonates die each year globally. The greatest burden (98%) of this neonatal death is shouldered by the low and middle-income countries. In Ethiopia, despite promising achievement in under-five mortality reduction, the rate of decline in neonatal mortality remained very slow, with recent status of 37 deaths per 1000 live births.

Birth preparedness and complication readiness and the minimum neonatal care package along the continuum of care starting form pregnancy, during labour and delivery and the immediate postpartum period have been identified as comprehensive strategies to address the high neonatal mortality. However, the status of birth preparedness and complication readiness, the provisions of the minimum neonatal care package, their determinants and effects on neonatal health status have not been well investigated at the local context. Moreover, studies on the causes and determinants of the high neonatal mortality in Ethiopia in general and in Jimma Zone in particular are very scarce. Thus, there is a need to conduct a study and identify gaps for policy and program improvement.

Objectives

The objectives of the study were to assess the status of birth preparedness, complication readiness, neonatal care practices and their effect on neonatal health status in Jimma zone, Southwest Ethiopia.

Methods

This study was conducted in Jimma Zone, Southwest Ethiopia, from September 2012 to December 2013. Mixed study designs, including cross-sectional and prospective follow up, involving both quantitative and qualitative methods were employed. A sample of 3612 pregnant women, who were identified from 73 clusters selected by multistage sampling techniques were included in the study. Community based surveys by using structured interviewer-administered questionnaires were conducted to collect the quantitative data. In-depth interviews and focus group discussions were conducted with purposively selected participants to collect the qualitative data. Descriptive analyses were done by computing

summary statistics and proportions. Univariate, bivariate and multivariate analyses were done based on the objectives of the study. Because of the multistage-clustered sampling method, multilevel analyses were done to identify factors affecting the outcomes of interest at different levels. Odds ratios and β-coefficients along with 95%CI were used to show the strengths of associations. Verbal autopsies were also conducted to ascertain the causes of neonatal death. The qualitative data were transcribed in to English and analysed thematically.

Results

From 3612 pregnant women enrolled to the study at the baseline, 3463 live births occurred and included in the final analysis making a response rate of 95.9%. The status of birth preparedness and complication readiness practice was 23.3% (95% CI: 21.8%, 24.9%). Place of residence and access to health centres were cluster level factors having significant association with birth preparedness and complication readiness. Maternal educational status, husband‘s occupation, wealth quintiles, knowledge of key danger signs during labour, attitude towards birth preparedness and complication readiness and antenatal care use were identified as individual level factors affecting birth preparedness and complication readiness.

The coverage of skilled care use in this study was 17.5% (95% CI: 16.2%, 18.8%). The most common reasons for not using skilled care were lack of transport (31.1%), home delivery was the usual place (24.0%) and perception that home delivery was more comfortable (23.1%). Place of residence and access to health centres were identified as higher-level factors affecting skilled care use. Maternal educational status, husband‘s occupation, wealth quintiles, gravida, inter-birth interval, knowledge of key danger signs during labour, antenatal care use and birth preparedness and complication readiness plan were identified as lower level determinants of skilled care use.

The status of neonatal care practice was 59.5% (95%CI: 57.6%, 61.3%). Place of residence, maternal education, husband‘s occupation, wealth quintiles, birth order and inter-birth interval were identified as factors affecting neonatal care.

This study found neonatal mortality rate of 35.5 (95%CI: 28.3, 42.6) per 1000 live births. Birth asphyxia (47.5%), neonatal infections (34.3%) and prematurity (11.1%) were the three leading causes of neonatal mortality. Cluster-level variables were found to have non-significant effect on neonatal mortality. Individual-level variables such as birth order, frequency of antenatal care use, delivery place, gestational age at birth, premature rupture of membrane, complication during labour, twin births, size of neonate at birth and neonatal care practice were identified as determinants of neonatal mortality.

Conclusions

The statuses of birth preparedness and complication readiness as well as skilled care use were found to be low in the study area. Though the status of neonatal care practice was relatively better, neonatal mortality was found to be high. The higher-level factors had significant effects on birth preparedness and complication readiness, skilled care use and neonatal care practice, but had non-significant effect on neonatal mortality. Instead, individual level factors related to intra-partum conditions and care as well as neonatal conditions and care had significant effect on neonatal mortality. Birth preparedness and complication readiness had significant effect on skilled care use, but had non-significant effect on neonatal mortality. Neonatal care practice had significant effect on neonatal mortality. The study identified birth asphyxia, neonatal infections and prematurity as major causes of neonatal death.

Recommendations

Increasing access to health facilities and means of transportation, strengthening community-based interventions to promote skilled care use, reducing the delays in care seeking for obstetric complications and neonatal care practices are recommended. Besides, designing appropriate context specific behaviour change communication strategies both at the facility and at the community levels to improve service use and minimize the existing barriers are needed.

Key words: *Birth preparedness, complication readiness, skilled care, neonatal care, neonatal mortality, Southwest Ethiopia*

1. INTRODUCTION

1.1. Background

The fourth Millennium Development Goal (MDG_4) calls for reducing the under-five mortality rate by two-third (67%) between 1990 and 2015. However, only 47% decline in under-five mortality and 37% decline in neonatal mortality had been achieved until 2012 globally. As a result, about 6.6 million children die before their 5^{th} birthday each year. About 5 million of this occurs in the first year of life and nearly 3 million die within the first 28 days of birth. This indicates that about 44% of under-five deaths and 60% of infant deaths are accounted by the neonatal mortality. Moreover, the share of neonatal mortality from the under-five death rose from 37% in 1990 to 44% in 2012 (1).

About 98% of these deaths occur in developing countries. Sub-Saharan Africa is, by far, the region of the world with the highest level of neonatal and infant morbidity and mortality and remained the most troubling geographic area. In this region, one in every six children dies before age one, which is more than 15 times higher than the average for the developed countries. Most of these deaths are caused by infectious diseases, pregnancy-related complications and delivery-related complications, including intra-partum asphyxia, birth trauma and premature birth which can easily be prevented (2, 3).

New knowledge and technologies have also been searched for by global health actors, including researchers, policy makers and program implementers for many years. However, the issue of neonatal survival remained unfinished agenda and is among the unachieved millennium development goal targets identified for the post-2015 priorities (4, 5).

In Ethiopia, studies indicate that there is promising evidence in the decline of child and post-neonatal mortality in the last 15 years. However, the rate of decline in neonatal mortality remained stagnant. According to Ethiopian demographic and health surveys (DHS) of 2000, 2005 and 2011, the under five mortally rates per 1000 live births were 166, 123 and 88 deaths, respectively. Similarly, the infant mortally rates per 1000 live births were 100, 77 and 59 in the three DHSs, respectively. However, the neonatal mortality rates were 42, 39 and 37 deaths per 1000 live births in DHS 2000, 2005 and 2011, respectively (6-8).

These show that in Ethiopia, although child survival programs have helped reduce the death rate among children under age 5 over the past 15 years, the biggest impact has been on reducing mortality from diseases that affect infants and children more than 1 month old. As a result, the vast majority of infant deaths occur during the first month of life, when a child‘s risk of death is nearly 15 times greater than at any other time before his or her first birth. This, in part, is explained by the low coverage of the minimum neonatal care package along the continuum of care as well as delays in recognition of neonatal morbidities and treatment seeking behaviour of mothers. These problems are again exacerbated by demographic, poor socio-economic status, low coverage of maternal and child health, poor quality of services and maternal behaviours in utilizing the existing services (9, 10).

To address these problems, birth-preparedness and complication readiness (BP and CR) has been advocated as a comprehensive strategy aimed at promoting the timely utilization of skilled maternal and neonatal health care and addresses the three delays to care seeking for obstetric emergencies. It promotes active preparation and decision-making for births including pregnancy and postpartum periods by shared responsibilities of pregnant women, their families, the community and the service providers (11, 12).

Despite the importance of birth preparedness and complication readiness as well as neonatal care, studies on assessing their statuses and their contribution in the reduction of neonatal mortality in the local context are very limited. Thus, this study aimed to fill these gaps by conducting community based prospective studies.

1.2. Statement of the problem

The World Health Organization (WHO) defines neonatal mortality rate as number of deaths during the first 28 completed days of life per 1,000 live births in a given year or period. Despite important gains in recent years, the challenge of saving the lives and improving the wellbeing of newborns is still quite considerable. As estimated by United Nation‘s Children fund (UNICEF), from about 3 million newborns dying each year during the neonatal period, 25-45% occurs during the first day after birth and around 75% of these deaths occur in the first week of birth (1, 13-15)

The average annual rate of reduction in under-five mortality has accelerated from 1.2% a year over 1990-1995 to 3.9% over 2005-2012 globally. However, the decline in neonatal mortality remained very slow with average annual rate of decline of less than 2%. In many societies, neonatal deaths and stillbirths are not perceived as a problem largely as they are very common. Many communities have adapted to this situation by not recognizing the birth as complete and by not naming the child until the newborn infant has survived the initial period (1, 2).

In Africa, approximately 1 million babies are stillborn, of whom at least 300,000 die during labour each year. Further 1.16 million babies die in their first month of life and another 3.3 million children die before they reach their fifth birthday. Many more die at home, uncounted and invisible (16).

In Ethiopia, evidences show that the declines in neonatal and post neonatal mortality rates were very slow for a long period. However, in the last five years, remarkable decline has been observed in post neonatal mortality, while neonatal mortality remained very high. In the last five years, about 63% of infant deaths occurred during the first month of life as compared to 37% occurring in the remaining 11 months of life in the country. This clearly indicated the need for particular focus on neonatal mortality for the reduction of infant mortality and achieve the stated MDG target (7, 8, 17) .

Evidences also suggest that a significant proportion of neonatal morbidity and mortality in developing countries can be prevented by inexpensive, simple practices and interventions

along the continuum of care starting from before pregnancy, during pregnancy, delivery and postnatal period (2, 3, 18). These include tetanus toxoid immunization for mothers, proper nutrition including iron, foliate and iodine supplements, clean and skilled care at delivery, newborn resuscitation, prevention of hypothermia, early and exclusive breast feeding, clean umbilical cord care and management of pneumonia and sepsis (6-8, 19, 20).

The birth-preparedness and complication readiness package is also among the best strategies recommended by safe motherhood initiatives to address the three delays representing barriers that often result in preventable maternal deaths and promote service use that improve birth outcomes and neonatal morbidity and mortality. These delays include delay in recognition of problem, delay in seeking care and delay in receiving care at facility (11).

Birth preparedness and complication readiness at individual level includes knowledge of key danger signs, plan for where to give birth, plan for a skilled birth attendant, plan for transportation, a birth companion and identification of compatible blood donors in case of emergency. These enable the woman and her family for timely use of skilled maternal and neonatal care, especially during childbirth, based on the theory that preparing for childbirth and being ready for complications reduces delays in obtaining these cares (12).

Neonatal care is also of immense importance for the proper development and healthy life of a baby. As part of neonatal survival strategies, The Lancet Neonatal Survival Steering Team identified evidence-based cost-effective interventions and published in 2005 (21). Following this, the World Health Organization developed a minimum neonatal care package to be given during pregnancy, labour and childbirth, the immediate postpartum period and the first 28 days of life (22). Almost all countries, including Ethiopia, have adopted this strategy and have been implementing it for many years.

However, newborn care often receives less-than-optimum attention. In addition, newborn care is strongly influenced by women‘s social and health status and by home care practices for mother and newborn, as well as by maternal and newborn care services. Traditional care practices during delivery and immediately for newborn at home and in the community

inevitably affect the health of the neonates. But, the major challenge is lack of adequate up-to-date data on the local practices at the community level for program improvement (9, 23).

Thus, for program efforts already underway, it is critical to learn how to make the intervention more successful. Therefore, there is a need for research to identify gaps for more effective and efficient programs for the improvement of birth preparedness and complication readiness, neonatal care practices and thereby reducing neonatal morbidity and mortality.

1.3. Rationale of the study

As seen in the three consecutive demographic and health surveys, despite many interventions on infant survival and some improvement in reduction of post neonatal mortality, the rate of decline of neonatal mortality remained stagnant in Ethiopia. This might be because of the low coverage of maternal and neonatal care or the existing low socio-economic status of the community. For effective policy and program formulation, it is important to have adequate and up-to-date information on the status of maternal and neonatal care services use and their relation to neonatal mortality.

However, studies that comprehensively addressed the status of BP and CR and their connection with neonatal care practises and neonatal mortality are very limited in Ethiopia. Similarly, the statuses of provision of the neonatal care package and its actual effect in reducing neonatal mortality have not been well studied in the local context. Moreover, some of the few available studies are cross-sectional in design and may not be the preferred design to reveal the relationship between the services and neonatal mortality.

Therefore, this community-based prospective study aimed to fill these gaps by determining the status of birth preparedness and complication readiness and neonatal care practices and their contribution to the reduction of neonatal mortality. The findings of the study will also help in policy formulation and designing effective interventions to improve the birth preparedness and complication readiness, the provision of neonatal care practices and reducing neonatal mortality.

1.4. Literature review and conceptual framework

In order to conceptualize the study, the theoretical bases were reviewed from the existing related literatures and a conceptual framework was developed. The literature review tried to address the status of birth preparedness and complication readiness and affecting factors, the status of neonatal care practices and the status, causes and determinants of neonatal mortality. Up-to-date and relevant international, national and local literatures were reviewed with special emphasis to the developing countries.

1.4.1. The status of birth preparedness and complication readiness

The global safe motherhood community recognized birth preparedness and complication readiness as a component of essential safe motherhood program and strongly recommend that every pregnant woman and her family need to be prepared for birth and its complications (11, 12). However, the existing studies indicate that the statuses of BP and CR in most developing countries are less than 50%. For instance, in a study conducted in Burkina Faso, in 2006, 43.4% of the mothers were planned for birth and its complications (24). Similarly, in cross-sectional studies conducted in Indore city (in 2010) and Rewa district (in 2009) of India, 47.8% and 47.5% of the mothers were prepared for birth and its complications, respectively (25, 26).

In an interventional study conducted in Nepal from 2003-2004, 33% and 54% of the women were prepared for birth and its complication at the baseline and post interventions, respectively (27). A study conducted in Pakistan in 2009 also found that 22% of respondents had satisfactory knowledge on key danger signs during pregnancy and 17% arranged means of transportation (28). In a study conducted in Northern Nigeria in 2010, 6.2% planed for skilled care at birth, 19.5% saved money and 24.2% arranged means of transportation (29).

This low status of BP and CR has also been evidenced in Ethiopia. In a cross-sectional study conducted in North Ethiopia, in 2006, 22% of the respondents were prepared for birth and its complications. In the study, only 0.4% and 0.2% were able to mention all the three key danger signs during pregnancy and all the four key danger signs during labour, respectively (30). In another cross-sectional study conducted in Southern Ethiopia in 2007, 17% of the respondents prepared for birth and its complications. In the study, 8.1% and 7.7% identified health facility for delivery and arranged means of transportation, respectively (31).

1.4.2. Factors affecting birth preparedness and complication readiness

The factors that affect BP and CR may relate to socio-demographic, economic, maternal, family and services. Therefore, these points were kept in mind while reviewing the existing studies. In a study conducted in Burkina Faso, education of women, income, parity and ANC were identified as determinants of BP and CR (24).

Indian study of 2010 also identified maternal educational status, educational status of husband, ANC visit and knowledge of danger signs as factors affecting BP and CR. In same study, the common reasons for not identifying a trained birth attendant for delivery were lack of perceived need (19.8%), economic constraints (4.5%) and thrust in Traditional Birth Attendants (TBAs) (25). In a cross-sectional study in Nepal, access to information that influence the knowledge of communities were among the factors that affect BP and CR (27). The study conducted in Rewa District, India, also identified socio economic status, educational status and parity as determinants of BP and CR (26).

The community based study conducted in North Ethiopia also identified maternal education, marital status, parity, history of still birth and advice as predictors of BP and CR (30). In the community based study conducted in South Ethiopia, ANC and parity were the factors affecting BP and CR (31) .

1.4.3. Neonatal care practices

In this review, neonatal care practices were considered along the continuum of care starting from pregnancy through labour and delivery to the post natal period. The review also kept in mind and focused on the minimum neonatal care package developed by WHO (22).

Cleanliness and hygiene practices during delivery

Cleanliness at delivery whether at facility or home is essential in reducing the risk of infection for the neonate. Cleanliness requires mothers, families and birth attendants to avoid harmful traditional practices and prepare necessary materials. Clean hands by using gloves, delivery in a clean surface, clean cord cutting and tying cord with clean thread are important activities for safe delivery. However, despite many efforts, still in many countries, where deliveries are conducted by untrained people at home, these practices are rarely carried out (22).

In study conducted in Nigeria, in 2008, more than 30% of neonates received unsafe cord care and 69.3% ware rapped with old clothes. In the study, clean surface was used for 17% of mothers and 98.2% of the newborns were bathed within one hour after birth, which may lead to hypothermia (32). In an Indian study of 2007, only 0.6% of the newborns received complete thermal care and 77.8% of the newborns were bathed within six hours of birth (33). In a study conducted in Addis Ababa Town in 2010, 29.1% of neonates received the overall good care and optimal thermal care was given for 47% of the newborns (34).

Care of umbilical cord always needs special attention as it can function as the entry point for infections. World Health Organization recommends dry cord care (where nothing is placed on cord stump unless indicated). Various studies done in developing countries have reported that mothers apply substances like mustard oil, turmeric, cow dung, antiseptic or lotion on the cord stump (32-37) .

In a facility based study conducted in India in 2009, 26% applied coconut oil, 5% applied antibiotic creams and 2% applied medicated powder and ash (37). In a study conducted in Nigeria in 2008, 70.3%, 4.7% and 1.3% of the mothers applied methylated spirit, oil and antiseptic to umbilical stump of their newborn, respectively (32). A study in India found that for 37.9% of the neonates, some form of substance was applied on the umbilical cord immediately. The most commonly used substance was pure ‗ghee' (25.0%), followed by some kind of antiseptic like ‗savlon' (7.9%), mustard oil (5.0%), talcum powder (4.7%) and Neosporin powder (4.1%) (33).

In a study in Pakistan, immediate bathing was given to 56% of neonates. Application of substances on umbilical cord (58%) and body massage (89%) were also the common poor neonatal care practices (38). In a population-based survey conducted in Uganda, there were low levels of coverage of newborn care practices. In the study, only 38% were judged to have had good cord care. About half of the mothers put substances (such as powder, surgical spirit, salty water or lizard droppings) on the cord stump (39).

Newborn feeding

Breast milk provides optimal nutrition and promotes the child‘s growth and development especially, during the first few months of life. The WHO recommends early initiation of breast milk (within one hour of birth) and avoiding extra feeding up to 6 months of age. However, studies show that plain water, sugar or animal milk is sometimes given to the newborns before the initiation of breastfeeding. A study in Nigeria found that, 97% of mothers gave colostrums to their babies as the first feed. However, only 65.3% initiated in the 1st hour of birth (32).

According to a study conducted in Philippines, while 68.2% of neonates started breast milk immediately, they were separated two minutes later (36). In a study in India, less than a third (31.2%) of mothers initiated breastfeeding within one to five hours of birth, while more than half of the women (58.1%) delayed breastfeeding by about one day or later after birth. Large majority of mothers (93.6%) gave the newborn some pre-lacteal feed before starting breastfeeding. The most common pre-lacteals given were herbal concoction (48.1%), black tea (46.7%) and honey (16.9%) (33).

In a community-based study in Uganda, less than half of neonates initiated breast feeding within the first hour of birth. The pre-lacteals given included cow milk, plain water, sugar, glucose water, gripe water and tea (39). In the study conducted in Addis Ababa Town, Ethiopia, nearly 40% didn't start breast feeding within one hour of birth and started any form of additional feeding in the first month of life (34).

1.4.4. Magnitude of neonatal mortality

The reviewed literatures show that the magnitudes of neonatal mortality in most of the developing countries are still high. For instance, a study in Nepal found neonatal mortality rate of 38 per 1000 live births (40). In Tunisian study of 2007, neonatal mortality rate was 12 per 1000 live births (41). In a study in Pakistan, neonatal mortality rate was 27 per 1000 live births with the majority of deaths occurring during the first three days of life (38). In a local study conducted around Gilgel Gibe field research centre, Southwest Ethiopia in 2005, neonatal mortality rate was 38 per 1000 live births (42). In Ethiopian DHS 2005 and DHS 2011, the neonatal mortality rates were 39 and 37 deaths per 1000 live births, respectively (7, 8). Similarly, in a study done in North Godar Zone, Ethiopia, in 2009, the rate of neonatal mortality was high, 43.8% (43).

1.4.5. Factors affecting neonatal mortality

In this review, factors affecting neonatal mortality were considered at different levels including immediate and direct causes at individual neonate level, factors at the household/family levels, underlying factors at community/district level and basic factors at the societal level. However, because of the scope of the study, much of the basic factors at the society level were not addressed in this literature review.

Direct causes of neonatal mortality

Newborn deaths result from a combination of medical causes, social factors and health system failures that vary by context and culture. In most settings, newborn health is closely associated with maternal health. According to WHO, the leading direct causes of newborn deaths globally are neonatal infections or sepsis (33%), birth asphyxia (28%) and congenital malformations (10%) (44).

In different countries, specific studies identified almost similar causes. According to Nepal study of 2010, the three leading causes of neonatal deaths were birth asphyxia (37%), severe infection (30%) and prematurity (15%) (40). A study in Nigeria showed that low birth weights, prematurity and neonatal tetanus were the major contributors of neonatal death (45). Similarly, in Tunisian study of 2007, prematurity, neonatal respiratory distress, perinatal asphyxia, nosocomial infection and small for gestational age (SGA) were the major causes of neonatal deaths (41). In the study conducted around Gilgel Gibe field research centre, Ethiopia, the two common causes of neonatal deaths were prematurity (26.4%) and pneumonia (22.6%) (42).

Underlying factors for neonatal mortality at household or family level

The underlying factors at the household or family level in this literature review involved maternal socio-demography, socio-economy and maternal obstetric factors such as parity and inter-pregnancy intervals.

Maternal Age

A number of investigations in industrialized and developing countries provided evidences supporting a role for biologic factors in poorer pregnancy outcomes of young mothers.

There are also some studies showing that maternal age has no effect on neonatal mortality. For example, in a study conducted in Philippines, maternal age had no significant association with neonatal death (46). Similarly, the findings of the study done in Western Australia by analyzing 20 years database showed contradicting findings. In the 1984-1993 periods, younger ages (<20 years) and older ages (35-39 years) were found to increase the risk of neonatal mortality as compared to middle ages (25-29 years). However, for the periods 1994-2003, it had no significant association after controlling for parity and socio-economic factors (47). In the same way, a 7 years cohort study conducted in Netherlands found that maternal age had no significant association with neonatal death after controlling for known confounding factors (48).

However, a cross-sectional study done in rural Nepal found that neonates born to mothers aged 12-15 years were at a higher risk of neonatal mortality than those born to women aged 20-24 years. Low birth weight, preterm delivery and small-for-gestation age which are related to low maternal age were strongly associated with neonatal mortality in the study (49). Similarly, a cross-sectional study done in Latin America reported a 50% excess risk of early neonatal mortality among mothers 16 years of age or younger as compared to mothers 20-24 years of age (50). A retrospective cohort study conducted in Manchester, UK, also found maternal age of younger than 25 years yielded increased risks of preterm delivery, low birth weight (LBW) and neonatal mortality (51).

Study in Hungary found that weight at birth and gestational age were the most important determinants of neonatal mortality and mother's age had an indirect and detrimental effect. When mothers are older than 30 years of age, the risk of lower birth weight or multiple births and in consequence neonatal mortality is increased (52).

The controversy documented in different studies may be because of methodological differences. The study in Australia was retrospective database analysis and study in Netherlands was cohort study. They used age cut-off 20 years and 25 years, respectively. They did not consider those less than 16 years separately. This may be the reason why maternal age had non-significant association with neonatal mortality. However, in the case of the other studies, even though they were cross-sectional in nature, they have looked at those less than 16 years separately and found significant difference.

Parity and inter-birth interval

The adverse consequences of a short inter-birth interval for neonatal survival have been attributed to the biological effects related to the ―maternal depletion syndrome" or more generally the woman not fully recuperating from one pregnancy before supporting the next one, which leads to anaemia, premature rupture of membranes and premature birth. Other reasons include competition for maternal resources and lack of adequate care (53)

According to a study done in India, short preceding birth interval had negative effect on the probability of neonatal death (54). In Indonesian study of 2008, the odds of neonatal death was higher for higher rank infants with a short birth interval (55). Similarly, in Bangladesh, short birth interval (<15 months) and very long interval (84^{+} months) were found to increase the risk of neonatal death (53).

Education

The relationship between maternal education and neonatal mortality is complex, but several studies have demonstrated reduced rates of neonatal mortality in association with increased levels of maternal education. This association is partly explained by the economic advantages and access to health care afforded by education. Potential links between maternal education and reduced neonatal mortality also include appropriate birth spacing and health care-seeking behaviour, particularly for prenatal care (56).

Study in Bangladesh found that Neonatal Mortality Rate (NMR) is higher in illiterate mothers group (125 per 1000 live births) as compared to 26 per 1000 live births among mothers who have some secondary education (56). In the study conducted around Gilgel Gibe, Ethiopia, in 2005, maternal education, practice and perception of mothers on the severity of illness and benefits of modern treatment were found to be independent predictors of neonatal mortality (42)

Income

Household income also determines the economic status, nutrition, housing condition, access to health care and clothing of a family. In developing countries, many researchers have identified that household income have strong relationship with NMR. In a Bangladesh study of 2010, NMR was higher (80 per 1000LBs) for households having monthly income

level of ≤30USD as compared to households having income level of >30USD (29.4 per 1000LBs). In the same study, types of latrine and possessing electricity which are indicator of income were also among the factors affecting NMR (56). A study in India found that NMR among the poorest 20% of the population was more than double of the NMR of the richest 20% (57).

In Ghana, neonatal mortality has shown significant decline because of improvement in socioeconomic status. According to the 1988 and 2008 DHS of Ghana, NMR were 40.7 and 30 per 1000LBs, respectively showing a decline of more than 10 neonatal deaths per 1000 live births in 20 years period because of improvement in socioeconomic status (58).

Employment and type of occupation

Regarding the relation between employment and neonatal mortality, literatures show two controversies. When parents are employed, they get high income and give better care for their neonates, which lead to low neonatal mortality. On the other hand, when parents are employed, they are unable to give care for their neonates because of work leading to high neonatal mortality (55).

In Indonesian study of 2008, the odds of neonatal death were higher for infants born to both mother and father who were employed and for infants born to father who were unemployed (55). Similarly, a study in Bangladesh show that NMR among labourer mothers were higher (166.7 per 1000 live births) as compared to housewives (36.7 per 1000 live births). Father‘s occupation of labourer also had higher NMR (85.7 per 1000 live births) as compared to service worker fathers (58.8 per 1000 live births) (56). However, in the study done by analysis of Bangladesh DHS of 2000, parents‘ occupation has no statistically significant association with the rate of NNM (59).

Health care related factors

Access to maternity and neonatal care services and care seeking practices are among the major factors contributing to neonatal mortality globally (17). Neonatal deaths and stillbirths stem from poor maternal health, inadequate care during pregnancy, inappropriate management of complications during pregnancy and delivery, poor hygiene during delivery and the first critical hours after birth (60). Study in Nigeria showed that not attending ANC and home deliveries were found to increase the rate of neonatal death (45). In Indonesian

study of 2008, a reduction in the odds of neonatal death was observed as the percentage of deliveries assisted by trained delivery attendants in the cluster increased. In the same study, mothers who had history of delivery complications had high odds of neonatal mortality. Neonates receiving postnatal care were significantly protected from neonatal death (55).

In India, it was documented that states with higher institutional births had lower neonatal mortality as compared to those with lower institutional births (57). The systematic review and Delphi estimation of mortality effect conducted on more than 20 studies in developing countries showed that care during labour and birth had significant effect in reducing neonatal mortality (61).

The findings indicated that comprehensive emergency obstetric care reduced intra-partum related neonatal deaths by 85%, basic emergency obstetric care resulted in reduction of intra-partum-related neonatal deaths by 40% and skilled birth care alone resulted in 25% reduction of intra-partum-related neonatal deaths. In the same review, a 6% reduction in all-cause perinatal or neonatal deaths and 11% reduction in birth asphyxia was reported in areas served by trained TBAs (61). However a 7 years cohort study conducted in the Netherlands found no significant differences in the relative risks of perinatal mortality among home births as compared to hospital births (48).

In a systematic review and meta-analysis we conducted just before this study, in 10 of the 19 studies included in the analysis, health facility delivery had significant effect on neonatal mortality; while in nine of the studies it had non-significant association. However, the overall pooled effect showed significant effect and health facility delivery had reduced the rate of neonatal mortality by 29% (95%CI, 13%, 46%) (62) (Annex 1.1).

In general, the reviewed literatures identified maternal biological and obstetric factors (age at birth, parity and inter-pregnancy interval), socio-demographic factors (education, income, marital status, occupation and employment) and maternal and neonatal health care practices as factors affecting neonatal mortality. As indicated in the literature review above, still there are some contradicting evidences about the relationship between some of these variables and the neonatal mortality. In addition, limited studies exist concerning determinants and causes of neonatal mortality in Ethiopia in general and in Jimma Zone in particular necessitating the conduct of this study.

1.4.6. Conceptual framework of the study

Based on the reviewed literatures, the conceptual framework indicated below was developed. To see the factors affecting neonatal mortality at different levels, they were divided in to three levels. The basic factors at the society level, the underlying factors at the community level and individual factors at the maternal and neonate levels.

The basic factors at the society level such as the political, policy, available resources, cultural and religious factors affect the underlying factors operating at the district and community levels. The underlying factors at the community level encompass place of residence and access to Basic Emergency Obstetric Care (BEmOC) and Comprehensive Emergency Obstetric Care (CEmOC). The community level factors in tern affect the individual maternal factors. These individual maternal factors include socio-demographic and economic factors, past obstetric history, birth preparedness and complication readiness and utilization of maternal and neonatal health care.

Among the individual factors, the socio demographic and economic factors affect the maternal obstetric factors, which in turn affect the preparation for birth and its complication. The preparation and readiness in turn affect the actual use of the services including skilled care at birth and neonatal cares. These individual level factors initiate and exacerbate the occurrence of neonatal morbidity and treatment-seeking behaviour of the mothers. Finally, these all factors lead to either neonatal survival or death. The detail conceptual framework is presented bellow diagrammatically (Figure 1).

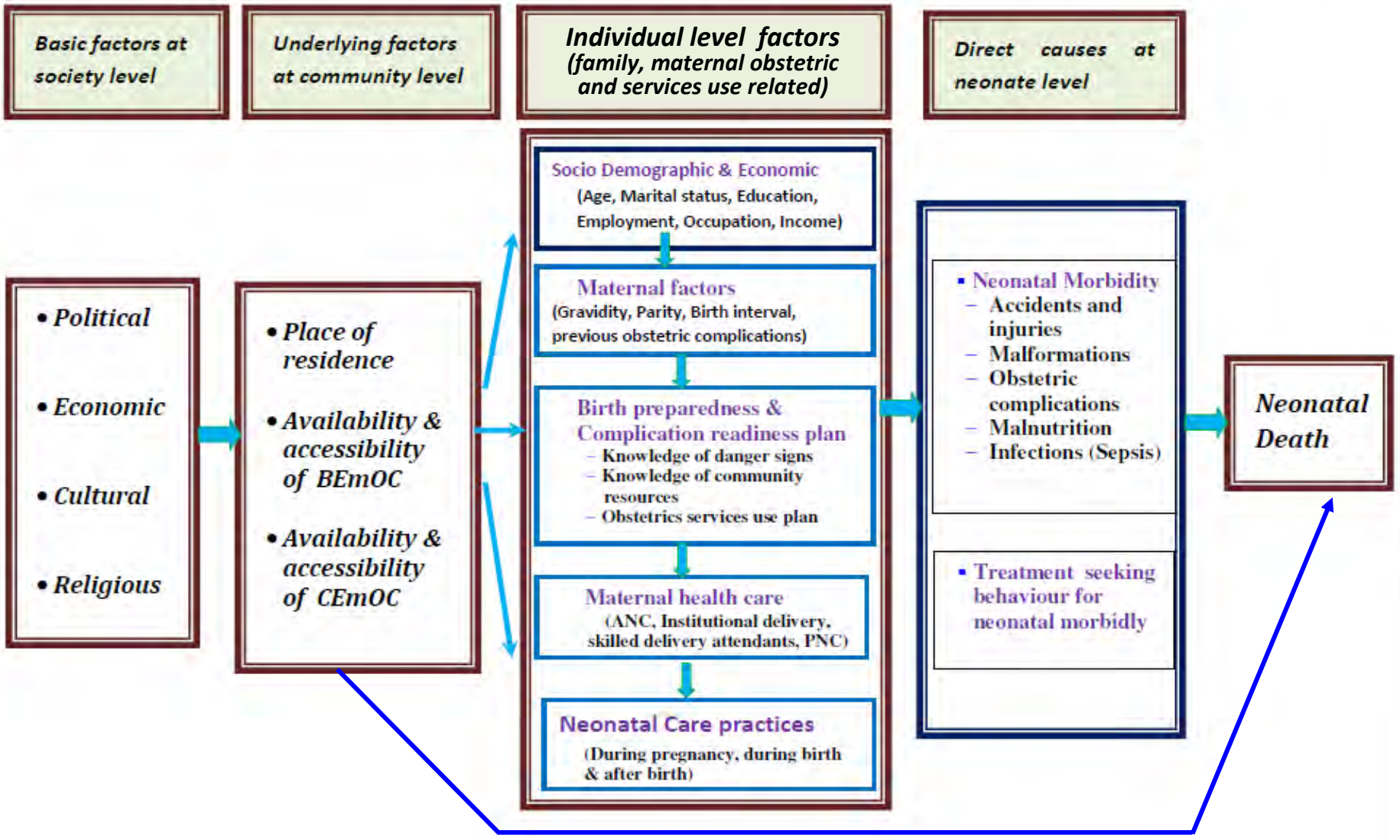

Figure 1. Conceptual framework of the study, Jimma Zone, Southwest Ethiopia, Sept 2012- Dec 2013

2. RESEARCH QUESTIONS AND OBJECTIVES

2.1. Research questions

1. What are the status of birth preparedness and complication readiness and factors affecting in Jimma Zone?
2. Does birth preparedness and complication redness plan have a significant effect on skilled care use at birth and neonatal mortality?
3. What are the status of neonatal care practices and factors affecting in Jimma Zone?
4. What are the status, causes and determinants of neonatal mortality in Jimma Zone?

2.2. Research objectives

General objective

- To assess the status of birth preparedness and complication readiness, neonatal care practice and their effect on neonatal health status in Jimma zone, Southwest Ethiopia.

Specific objectives

1. To determine the status of birth preparedness and complication readiness and identify factors affecting.
2. To assess the effect of birth preparedness and complication readiness on skilled care use.
3. To assess the status of neonatal care practice and factors affecting.
4. To determine the status of neonatal mortality and identify the causes and determinants.

3. METHODS

3.1. Study area and period

This study was conducted in Jimma Zone, Southwest Ethiopia. Jimma Zone is one of the 17 Zones of the Oromia Regional State of Ethiopia. It was named for the former Kingdom of Jimma, which was absorbed into the former province of Kaffa in 1932. The zone has a total area of 18,412.54 km square and its location extends from 7 degree 13‘N to 8 degree 56‘N and from 35 degree 52‘E to 37 degree 73‘E. It is bordered to the South by the Southern Nations, Nationalities and People‘s Region (SNNPR); to the Northwest by Illubabor, to the North by Misraq Wolega and to the Northeast by Mirab Shewa; part of the boundary with Misraq Shewa is defined by the Gibe River. The Zone has a total of 17 rural districts called *Woredas*‘ and two town administrations. Jimma town, the capital of the Zone, is located at 346 kms Southwest of Addis Ababa, the capital city of Ethiopia (63) (Figure 2).

Based on the 2007 national population and housing census, the Zone has a total population of about 2.6 million with a male-to-female ratio of 1.01:1. The great majority of the populations (89%) are rural residents. The Zone has a total of 521,506 households with an average household size of 4.77 persons per a household (63). The ethnic groups found in the zone include Oromo (81.6%), Yem (5.4%), Amhara (4.6%), Dawuro (2.9%), Kafficho (1.9%) and others (3.6%). Muslims (82.3) were the dominant religious group followed by Orthodox Christians (15.8%).

As of May 2011, the Zone has 4 hospitals, 100 health centers and 519 community health posts. All the facilities are expected to provide maternal and neonatal health care services based on the National Essential Health Services Packages (EHSP) for different levels of health care. The potential health service coverage of the zone for the year 2011was 52% (63).

Study Period: The study was conducted from September 2012 to December 2013

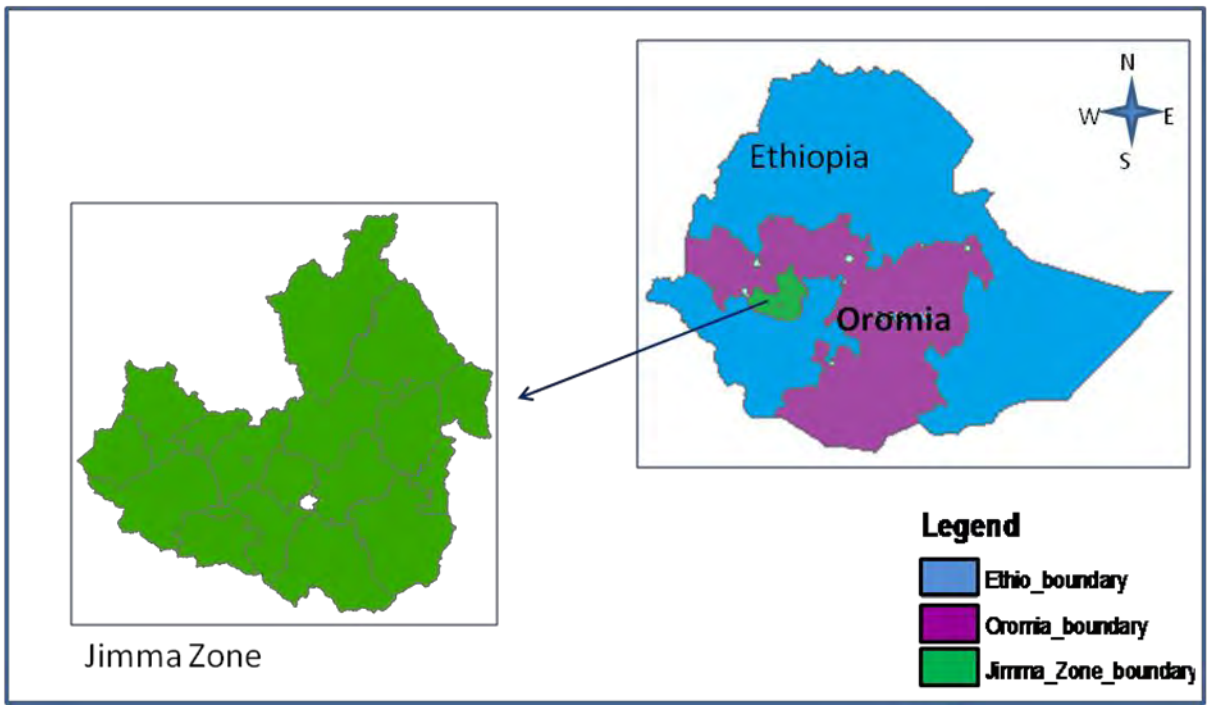

Figure 2. Map of the study area, Jimma Zone, Southwest Ethiopia, September 2012- December 2013

3.2. Study Design

Mixed study designs were used in this study. For objective 1, baseline cross-sectional study was conducted by employing both quantitative and qualitative methods to assess the status of birth preparedness and complication readiness and identify affecting factors.

For objectives 2-4, prospective follow up study, supplemented by qualitative methods, was conducted. i.e. All study participants for objective 1 (pregnant women) were followed up to 28 days post partum period to determine the effect of birth preparedness on skilled care use, the status and factors affecting neonatal care and assess the status, causes and determinants of neonatal mortality.

3.3. Population

Source population: For objective 1, all pregnant women found in Jimma Zone during the study period were considered as source population. For Objectives 2-4, all mothers who had given birth in 28 days period prior to the survey in the Zone with their neonates were considered as source population.

Study population for the quantitative part

For objective 1, the study population were randomly selected pregnant women from the source population and included in the study. For objectives 2-4, as this was a follow up study, all mothers who were selected and enrolled in the study for objective 1 with their neonates were taken as study population just at the end of 4^{th} week after birth.

Study population for qualitative part

For objective 1, to have in-depth investigation of the factors affecting birth preparedness and complication readiness, in-depth interviews (IDIs) with purposively selected family members (husbands), health extension workers (HEWs) and traditional birth attendants (TBAs) and focus group discussions (FGDs) with purposively selected pregnant women were conducted. For objectives 2-3, to assess more in-depth cultural factors acting as barriers to skilled care use and neonatal care practices, IDIs with purposively selected service providers, TBAs and HEWs and FGDs with purposively selected mothers having post neonatal infants (1-6 months) were conducted.

These key informants and FGD discussants were selected based on their close relation with mothers and assumed to be rich sources of information on the topic of the study. Family members (husbands) were assumed to play a great role in birth preparedness and complication readiness plan and also have to involve in the decision making process for maternal and neonatal services use. So, they were considered as key informants to look at their involvement and view on these cares.

Sampling units and study units: as this study involved multistage clustered sampling method, the primary sampling unit (PSU) was district (*Woreda*), the secondary sampling unit (SSU) was *Kebele* (cluster) and the final sampling unit was pregnant women. The study units or respondents were the individuals (women) identified at the last sampling unit.

3.4. Inclusion and exclusion criteria

Inclusion criteria

At enrolment for objective 1, pregnant women in the age group of 15-49 years, who reported to have pregnancy of 12 weeks or above were considered as eligible for the study. Eligibility were defined by absence of three normal menstrual flow for at least 3 consecutive cycles based on the WHO pregnancy screening criteria (64) (Annex 2.1). For objective 2, all mothers who had given either stillbirth or live birth were included in the study. For objectives 3-4, mothers who had been on follow up and given live births were included.

Exclusion criteria

At enrolment for objective 1, mothers whose reported pregnancy was less than 12 weeks were excluded. In addition, pregnant women, who were assumed to be unable to be interviewed to provide valid information because of mental, hearing, speaking or other medical problems, were excluded. Because of the follow up nature of the study, temporary residents (such as summer students) who were assumed to leave the study area before 28 days postpartum period were also excluded. Mothers whose pregnancies were ended in abortion were excluded from the follow up study and all still births were excluded from the analysis for objectives 3 and 4.

3.5. Sample size and sampling techniques

3 5.1. Sample size

To come-up to the final sample size for the quantitative part, separate samples were calculated for each of the four objectives and the largest sample was taken to enrol the study participants to increase power and level of precision. All the sample sizes were determined by using Epi-Info version 3.5.1 software.

Sample size for objective 1

The objective here was to determine the status of birth preparedness and complication readiness. At the same time, it was planned to look at the factors affecting birth preparedness and complication readiness. Thus, the sample size was calculated by using the two options to take the larger one.

The first sample size was determined to estimate single population proportion based on the following assumptions. The proportion of women prepared for birth and its complication was assumed to be 22% (p=0.22) (30). The allowed margin of error to be 3% (d=0.03) with 95% level of confidence (two-sided $\alpha = 0.05$). In addition, as a multistage-clustered sampling method was used, a design effect of 2 was considered. Finally, 10% was added for non-responses and the final sample size became 1610 pregnant women.

The second sample size to identify factors affecting birth preparedness and complication readiness was determined by considering two samples comparison of proportions. Among all the factors considered, antenatal care (ANC) was found to give the largest sample size. The proportion of women prepared for birth and its complication, among those who attended at least one ANC was estimated to be 22% (p_1=0.22) and among those who didn't attend ANC was to be 13% (p_2=0.13) (31); 95% level of confidence and 90% power were considered with a ratio of 1:1 (r = 1) for ANC users to non users. As multistage-clustered sampling method was used, a design effect of 2 was used. Finally, 10% was added for non-responses and the final sample size became 1650.

Sample size for objective 2

The second objective was to determine the status of skilled care use and to look at the effect of BP and CR on skilled care use. To estimate the status of skilled care use, the following assumptions were made. The proportion of women using skilled care at birth as taken from EDHS 2011 was 10% (P=0.10). Level of confidence of 95% and a margin of error of 2% were considered. After considering a design effect of 2 and non-response rate of 10%, the sample size became 1902.

To determine the sample size to look at the effect of BP and CR on skilled care use, the following assumptions were made by considering two samples comparison of proportions. As there was no similar study conducted in the country to be used as a base to determine the sample size, study from other country was used. In a study done in India, BP and CR was found to increase the skilled care use by 80% (25) .

Based on this, the proportion of mothers using skilled care among those who were not prepared for birth and its complication was taken as 10% (P_1=0.1) (8) and among those who were prepared for birth and its complication was estimated to be 18% (P_2=0.18) to detect 8% difference or 80% increment. A level of confidence of 95% and power of 90% were considered. A ratio of 1:4 (r=4) was used for exposed-to-non-exposed. Exposure was preparedness for birth and its complication and non-exposure was not preparing themselves for birth and its complication. After considering a design effect of 2 and 10% for non-responses, the final sample size became 2603 mothers.

Sample size for objective 3

The third objective was to determine the status of neonatal care practice and identify affecting factors. Thus, to estimate the neonatal care practice, the sample size was determined for single population proportion based on the following assumptions. The proportion of neonates receiving appropriate neonatal care as determined by the composite variable (indices) was assumed to be 29% (p=0.29) (34). The allowed margin of error to be 3% (d=0.03) with 95% level of confidence. In addition, as multistage-clustered sampling method was used, a design effect of 2 was considered. Finally, 10% was added for non-responses and the final sample size became 1934 mothers with their neonates.

To identify factors affecting neonatal care, two samples comparison of proportions was assumed. However, no similar study conducted before in similar setup. As a result, education was taken as one factor affecting neonatal care with 50% of the neonates receiving care among educated mothers (at least primary school). To detect 10% deference with 95% level of confidence, 90% power and ratio of 1:1 (r =1). After considering the design effect of 2 and 10% for non-responses, the sample size became 2284.

Sample size for objective 4

The 4th objective was to determine the status of neonatal mortality and identify the causes and determinant factors. Thus, the sample size to determine the status of neonatal mortality

was determined for single population proportion. The status of neonatal mortality as taken from previous study conducted in Gilgel Gibe research centre was estimated to be 38 deaths per 1000LBs, which was 3.8% (p=0.038) (42). A level of confidence of 95% and 1% level of precision (d=0.01) were used. Finally, after considering a design effect of 2 and 10% for non-responses and miss to follow up, the final sample size became 3090.

The sample size to identify determinants of neonatal mortality was also determined by considering two sample comparisons of proportions. Among all the determinants of neonatal mortality considered, educational status of mothers was found to give the largest sample size. Based on this, the prevalence of neonatal mortality among mothers having educational status of secondary or above was estimated to be 4.0% (p_1=0.040) and among those who didn't attend secondary education is to be 8.1% (p_2=0.081) (43), 95% level of confidence and 80% power were considered. A ratio of 1:3 was used (r = 3). Because of the multistage-clustered sampling method, a design effect of 2 was considered. Finally, 10% was added for non-responses and miss-to-follow up and the final sample size became 3604.

Finally, as this study was a prospective study that needs similar sample size, the maximum sample, 3604, was taken for all the four objectives. Taking this as a final sample size will increase the precession and power of the study for the rest of the objectives.

Sample size for the qualitative part

In-depth interviews and FGDs for objective 1: For in-depth investigation of cultural and community related factors affecting BP and CR, 4 family members (husbands), 4 TBAs and 4 Health Extension Workers (HEWs), a total of 12 key informants were interviewed. In addition, 6 FGDs (2 from urban and 4 from rural) having 8-10 purposively selected pregnant women, who were not part of the quantitative study, were conducted.

In-depth interviews and FGDs for objectives 2 and 3: to identify more cultural and community related factors affecting skilled care use and neonatal care practices, purposively selected 4 Integrated Management of Neonatal and Childhood Illness (IMNCI) service providers, 4 HEWs and 4 TBAs, a total of 12 Key informants were interviewed. In

addition, 6 FGDs (2 from urban and 4 from rural) having 8-10 purposively selected mothers having post neonatal infants aged 1-6 months, who were not part of the quantitative study were conducted. The number of interviews and FGDs were determined based on the level of saturation of information.

3.5.2. Sampling techniques

As this study was a prospective follow-up, same sampling method, multistage-clustered sampling technique, was used to identify study participants and enrol in to the study for all the four objectives. At first stage, the Zone was stratified as rural districts called *„Woredas"* (17 in number) and town administrations (2 in number, Jimma and Agaro). Then, by considering time and logistics, 5 districts (≈30%, rule of thumb) were selected by simple random sampling from the 17 districts. In addition, both the Jimma town administration and Agaro town administration were included purposefully.

At second stage, all the selected 5 districts were clustered by *Kebeles*‘ (A *Kebele*‘ is the smallest administrative unit having 5000 population on the average) and stratified in to urban and rural *Kebele*s. Following this, by using simple random sampling method, 9 rural *Kebele*s and 2 urban *Kebele*s were selected from each selected rural district.

Jimma town administration and Agaro town administration have 13 and 5 *Kebele*s, respectively and all were included. With this, a total of 73 clusters were included in the study. This number of clusters (*Kebele*s) to be included was determined based on proportional allocation to the size of the population of each district and expected number of pregnant women per *Kebele*. The population was projected from the 2007 national housing and population census for the year 2011. As taken from the local reports, in average about 30 and 60 pregnant women were expected to be found per urban and rural *Kebele*s, respectively. Then, for all selected *Kebele*s pregnant women were enumerated by using house-to-house visits and all obtained were enrolled in the study as they were slightly higher than the calculated sample size, 3682 Vs 3604 (Table 1, Figure 3).

Table 1. Determination of number of clusters required based on proportional allocation to size, Jimma Zone, Southwest Ethiopia, Sep 2012-Dec 2013.

Parameters	Strata				
	Jimma Town Administration	Agaro Town Administration	5 selected districts		Total
			Urban (10%)	Rural (90%)	
Estimated population	144,369	48,180	105, 059	945,526	1,243,134
Sample size allocated (proportional): (Pi/P)*n	419	140	305	2741	**3604**
Approximate # of pregnant women expected per *Kebele*	30	30	30	60	-
Approximate # of clusters needed	14	5	10	46	75
Actual # of clusters included	13 (All available)	5 (all available)	10 (2 per district)	45 (9 per district)	73
Actual # of pregnant women obtained during enumeration and enrolled in the study	412	156	346	2768	**3682**

P=Population, n=Sample size=3604

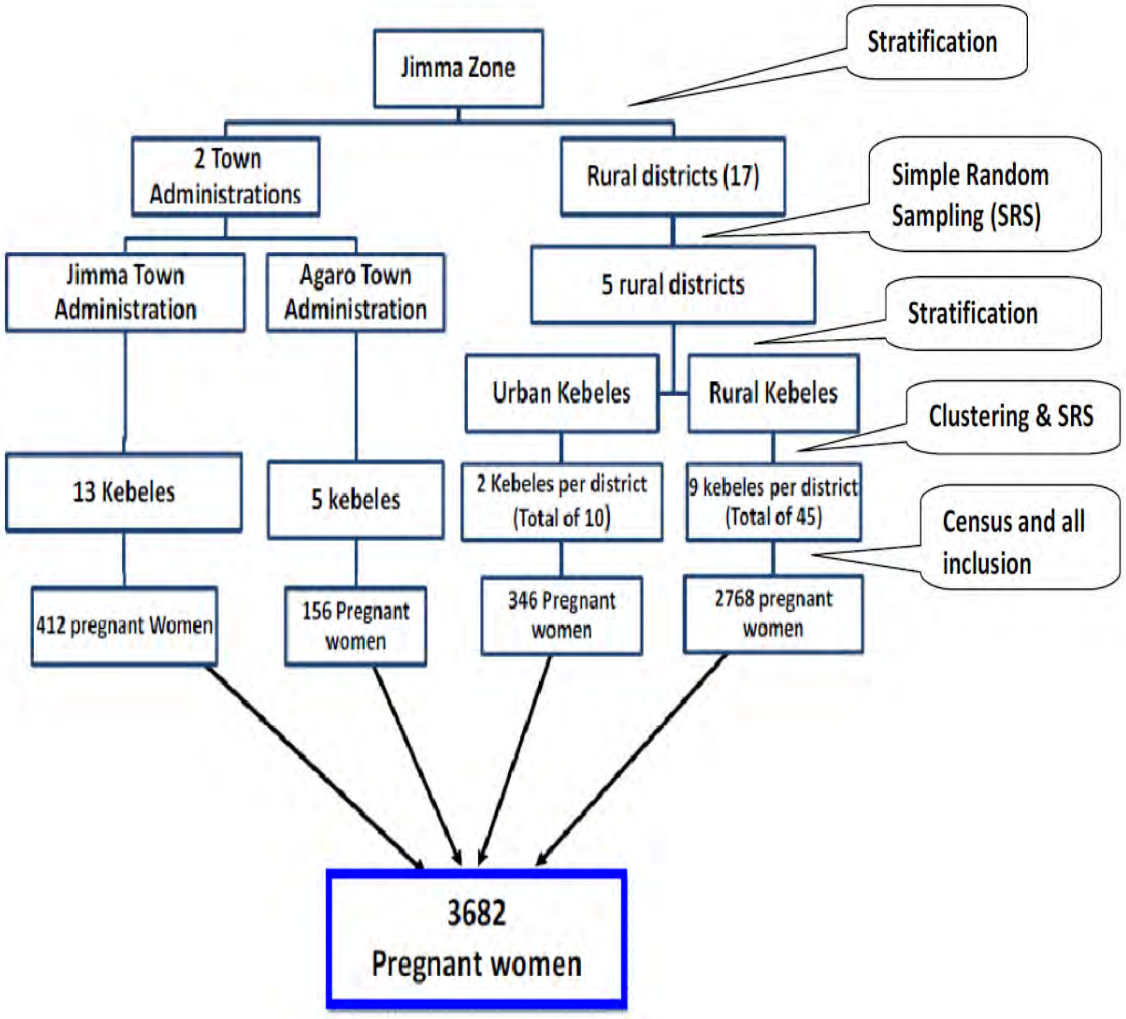

Figure 3. Schematic representation of sampling methods, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013

3.6. Data collection process

3.6.1. Variables

Dependent variables

- For objective 1: Birth Preparedness and complication readiness
- For objective 2: Skilled care use
- For objective 3: Neonatal care
- For objective 4: Neonatal mortality

Independent variables

- Higher level (level-2) variables
  - Place of residence, access to Basic Emergency Obstetric Care (BEmOC) and access to Comprehensive Emergency Obstetric Care (CEmOC).

- Lower level (level-1) variables
  - Socio-demographic characteristics such as age, educational status, marital status, occupation, husband‘s occupation, religion and ethnicity.
  - Economic status: wealth quintiles as determined by composite index.
  - Obstetric factors: age at birth, inter-birth interval, gestational age (GA), parity, gravidity, previous history of stillbirth and other pregnancy related complications.
  - Service use: ANC use (initiation time, frequency, provider, advise given during ANC)
  - Neonatal conditions: birth order, sex of neonate, size (weight) at birth and type of birth (multiple or singleton)

The detail measurements of all the dependent variables and independent variables are described in operational definitions and description of variables below (Table 2).

Table 2. Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, September 2012-December 2013

Variables	Descriptions	Measurements
Dependent variables		
Birth preparedness and complication readiness	A package of interventions composed of composite measure of 5 variables (planed to save money, planed to arrange transport, identified place of delivery, identified skilled attendant and identified blood donor)	Composite index was computed by adding the five responses. Women who scored 3 or more 'Yes' responses were categorized as ' well prepared' and otherwise 'not well prepared'
Skilled care	Deliveries conducted at health facility (hospital or health centre) attended by skilled attendants	Deliveries attended at health facility by health professionals were categorized as "skilled care" and other wise "non-skilled care"
Neonatal care	The minimum neonatal care package adapted from WHO having 12 items were used to create composite index by using PCA.	Mean score was computed and those scored above or equal to the mean were categorized as having 'good neonatal care' and otherwise 'poor neonatal care'.
Neonatal mortality	Death of the infant before 28 completed days	Neonates died before 28 days were categorized as neonatal death and coded as '1', those survived 28 days were coded as '0'
Level-2 predictor variables	**Communal (*Kebele*) characteristics**	
Place of residence	The usual place of residence where the woman lives	Urban *Kebele* was coded as '1' and rural *Kebele* as '2'.
Average distance from health centre (BEmOC)	Approximate distance of respondent's home from the nearest health centre on foot in munities as reported by respondent.	Average distance was computed for each *Kebele* and dichotomized as '≤2hours' and '>2hours'
Average distance from Hospital (CEmOC)	Approximate distance of respondent's home from the nearest hospital on foot in munities as reported by the respondent.	Average distance was computed for each *Kebele* and categorized as '≤2 hours', '>2-12hrours' or '>12hours'
Level-1 predictor variables	**Individual and household characteristics**	
Age	Age of women at interview in completed years	Categorized in to 7 groups by five-years interval, which later recoded in to three categories: '<20', '20-29' or '>29'
Ethnicity	The ethnic background of the respondent	Each ethnicity was entered and later recoded as 'Oromo' and 'Others'. Others were merged because they were very few for logistic regressions.
Religion	The religious background of the respondent	Each religion was entered and later recoded as 'Muslim' or 'Others'. Others were merged because they were very few for logistic regressions.

Table 2. Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (continued)

Variables	Descriptions	Measurements
Educational status	Highest level of education attained by the respondent and her husband	Categorized in to 4 groups as 'No formal education', 'Primary (1-8)', 'Secondary (9-12)' and 'Tertiary (12^{+})'.
Occupational status	Current employment status and specific occupation of respondent and her husband	Categorized as 'housewife' ('farmer' for husbands), 'employed in GO, NGO or private', 'merchant' and 'others'.
Wealth quintiles	Using EDHS questionnaire, house hold assets ownership were assessed and wealth index was computed by using principal component analysis	The wealth status was categorized in to five groups and ranked from poorest to wealthiest quintile.
Birth order	Number of births a woman ever had including current birth	The responses was categorized in to three categories as: '1^{st} birth order', '2^{nd} – 4^{th}' and "$\geq 5^{th}$ birth order'
Preceding birth interval	The duration between the current birth and the preceding birth in months.	The responses were categorized in to three as: '<24 months, '24-48 months' and ''>48 months. First birth orders were categorized as 'Nulliparous.'
ANC frequency	Having health facility visit for pregnancy check up by skilled attendants during pregnancy.	Categorized in to three: 'No ANC visit at all', '1-3 ANC visits' and '≥4 ANC visits'
Place of delivery	The place where the neonate was born	Categorized as 'home', 'Hospital' and 'Health centre'. Which later be merged as "Health facility" and "home'
Attendant of delivery	The person who assisted the mother during delivery	Those who have trained to the level of Diploma and above were categorized as "skilled attendants", and those who didn't train at all, TBAs/TTBAs and HEWs were categorized as 'Unskilled attendants'
Gestation age (GA) at birth	Approximate GA at birth by woman's own report in weeks	GA of <37 weeks were categorized as 'Premature birth' and GA of ≥37 weeks were categorized as 'Mature birth'.
Premature rupture of membrane (PROM)	Leakage of fluid before the onset of labour and the duration it stayed before the onset of labour in hours.	The responses were categorizes in to four as: 'No leakage before onset of labour'", '<1 hour', '1-12 hours' and '>12 hours'.
Duration of labour	The time between the onset of labour (contraction) to the expulsion of foetus	Categorized in to three as: '<6 hours', '6-12 hours' and '>12 hours'.
Complications during labour	The occurrence of one or more of the following complications: excessive bleeding, mother had convulsions, breech presentation, emergency C/S and multiple delivery.	The responses were categorized as 'Yes' if at least any one complication and otherwise categorized as 'No'.
Type of birth	Multiplicity of the birth (whether the delivery was multiple or singleton)	Twin births were labeled as '1' and singletons as '0'
Sex of neonate	The sex of the neonate, both for died and alive.	Males were coded as '1' and females were coded as '0'.
Size of neonate at birth	Size of the neonate at birth as judged by the mother as compared to other average neonates they know before.	The responses were categorized in to 3 as: 'small' 'average', and 'big'

3.6.2. Data collection instruments

For quantitative part

The data were collected by using pre-tested interviewer administered structured questionnaires which were adapted from different literatures. The indicators for the wealth index were adapted from EDHS (8) and included ownership of household assets and equipments, water supply, power supply, sanitary facility, residential homes, farmlands and livestock ownership.

Indicators to measure birth preparedness and complication readiness plan and index were adapted from the safe motherhood questionnaires developed by maternal and neonatal health program of JHPIEGO (11) and included knowledge of key danger signs, knowledge of community resources and services use plan. Indicators for neonatal care practices were adapted from the World Health Organization minimum neonatal care packages (22) and involved services during pregnancy, labour and child birth, the immediate post partum period and the first 28 days of birth.

Data on causes of neonatal death were collected by using structured verbal autopsy (VA) questionnaire adapted from the standard VA questionnaire developed and validated by WHO, Johns Hopkins University (JHU) and London School of Hygiene and Tropical Medicine (65). All the questionnaires were prepared in English, then translated to local languages *Afan Oromoo*‘ and Amharic and used to collect the data after back translating to English by different experts to check its consistency.

Instruments for the qualitative part: interview guides and FGD guides were prepared in line with the objectives of the study by the principal investigator and used to collect the data. All the guides were prepared in English and the interviews and discussions were made in local languages *Afan Oromo"* or Amharic based on the specific language preference of the interviewee and discussants.

Pre-test

All the instruments were pretested in a similar setup, but not part of the selected clusters for the study, before actual data collection and necessary modifications were made.

3.6.3. Data collection procedures

Data collectors

- The home-to-home visits to enumerate the pregnant women were conducted by females who had completed 10th grade or above, well familiar with local geography and fluent in local languages (*Afan Oromo"*and Amharic).
- The data at the baseline as well as follow-up phases for all the objectives were also collected by well experienced females, who had completed 10th grade or above and fluent in the local languages.
- The verbal autopsy to identify causes of neonatal mortality was conducted by experienced V/A conductors who had at least a qualification of Diploma and had been serving as V/A conductors for Gilgel Gibe Field Research center of Jimma University.

For the qualitative part

Experienced professionals, Masters of Public Health (MPH) holders, conducted the FGDs and in-depth interviews. Focused group discussions and in-depth interviews with female respondents were conducted by female data collectors and the interviews with male respondents were conducted by male data collectors. One data collector and one note taker participated per discussion and per interview. All the discussions and interviews were audio recorded after the consent of the respondents in order not to miss important information.

Supervisors

Bachelor of Science (BSc) holders (one per district or town administration) from the District (*Woreda*) health Offices were selected, trained and used as supervisors. In addition, 2 MPH holders from Jimma University supervised the overall data collection process together with the principal investigator. The supervisors had checked all the questionnaires daily and provided feedback immediately for the data collectors as needed. In case of incomplete questionnaires, the supervisors made the data collectors to re-complete. The Principal supervisor supervised the overall field-work and supervised the supervisors.

Training of data collectors and supervisors

Intensive five-days training was given for the enumerators, data collectors (quantitative, qualitative and VA) and supervisors separately on how to conduct the home to home enumeration and identify pregnant women, how to collect the data and how to supervise,

respectively. The training was given on the objectives of the study and the instruments by looking at all the questions one-by-one. Initial three-days training followed by one day field work and one day final discussions on the instruments were made. Amendments and necessary modifications were made before duplicating the final instruments.

Data collection

As this study was a prospective follow-up, the data were collected in three different phases.

- First, before actual data collection, list of eligible pregnant women (sampling frame) were obtained by conducting home-to-home enumeration (census) for all the selected 73 clusters. During this phase, district, *Kebele*, *„Got", „Gare",* house number, name of head of household and list of all pregnant women in the household were recorded. Then, specific identification numbers (codes) were given for all the registered pregnant women to avoid identifiers and to link the data during the follow-up.

- Second, baseline data for objective 1 were collected. During this phase, data on basic socio-demographic characteristics, household assets to compute wealth index, indicators of BP and CR index and the five elements of BP and CR practice were collected. Qualitative data for objective 1 were also collected during this time just following the completion of the quantitative part.

- Third, data for objectives 2-4 were collected. This was made just at the end of neonatal period, within 28-42 days. During this phase, data on actual place of delivery, delivery attendants, neonatal care practice and neonatal death were collected. Verbal autopsy for died neonates were also conducted during this phase simultaneously. Qualitative data for the objectives 2 and 3 were also collected following this phase.

3.7. Data quality control

To ensure the quality of the data, local languages were used for more understanding of the questions. In addition, pre-test of research instruments and thorough training of data collectors and supervisors were made before actual data collection. The inter-item consistency of the indicators to measure the composite score of BP and CR as well as neonatal care practice was checked by using Chronbach-alpha at 0.7 cut-off points. Close supervision and daily checking of the questionnaires were also made to ensure completeness and consistencies.

3.8. Data management and analysis

The collected quantitative data were coded and entered into Epidata V.3.1 to minimize logical errors and design skipping patterns. Then, exported to SPSS for windows version 20.0 for cleaning, editing and analysis. Descriptive analyses were done by computing proportions and summary statistics. Socio-economic quintiles were determined by using Principal Component Analysis (PCA).

Birth preparedness and complication readiness practice and index were determined by calculating proportions along with 95% confidence intervals. For the neonatal care practice, a score (composite index) was determined by using 13 items (indicators) by using PCA and dichotomized based on mean score. Neonatal mortality rate was determined per 1000live births along with 95% confidence interval. As Jimma town administration and Agaro town administration were both purposefully included, there might be over representation of the urban women. As a result, weighted analysis was done to estimate the necessary parameters based on complex-sample survey procedure by considering probability of exclusion at each stage, missed-to-follow-up and non-responses.

To identify factors having significant associations, separate models were used for all the four objectives. The dependent variables for objective 1 (BP and CR), objective 2 (skilled care use) and objective 4 (neonatal mortality) were binary (dichotomized) outcomes. Whereas, dependent variable for objective 3 (neonatal care practice) was composite indices that was treated as continues variable. For all the objectives, first, bivariate analysis were done by using cross tabulations to see associations between the independent and dependent variables by identifying the explanatory variables based on the conceptual framework. Then, all variables having P-value <0.25 were considered as candidates for the multivariable regression models.

As multistage-clustered sampling method was used because of the different levels of factors, mixed-effects multilevel analyses were done for all the four objectives. Mixed-effects multilevel logistic regression model was used for the binary and mixed-effects multilevel linear regression model was used for the continues outcome by using STATA 13. This model was preferred in order to avoid the clustering effects as the factors exist at different level and violate the assumption of independence for the ordinary logistic regression.

*Kebele*s were considered as clusters and *Kebele* level variables were taken as higher level (level-2). Neonates and mothers were nested within their family and households and individual neonatal, maternal and household variables were taken as lower level (level-1) variables. Goodness of fit of the multilevel models were tested for all the objectives by using the log likelihood ratio (LR) test. To evaluate the existence of sufficient variations at the cluster level influencing the dependent variables, intercept-only models were fitted for all the objectives separately as Logit (p_{ij}) = $\gamma_{00} + u_{0j}$ and Interclass Correlation Coefficient (ICC) was determined by using the following formula.

$$ICC(\rho) = \frac{\text{Variance between groups}(\delta^2\mu_0)}{\text{Variance between groups}(\delta^2\mu_0) + \text{Variance within group}(\delta^2 e)}$$

As within group variance ($\delta^2 e$) is not directly obtained for dichotomous outcome variables; it was estimated by $\prod^2/3$ as follows: $ICC(\rho) = \frac{\delta^2\mu_o}{\delta^2\mu_o + \frac{\Pi^2}{3}}$

Then, to identify the determinant factors, the full model was fitted as:

$$\text{Logit}(p_{ij}) = \gamma_{00} + \gamma_{01} Z_j + \gamma_{10} X_{ij} + u_{0j} + u_{1j} X_{ij.}$$

Where: Logit(p_{ij}) = dependent variable at unit i in cluster j, X_{ij} = individual explanatory variable in cluster j, Z_j = group level explanatory variable, γ_{00} = fixed intercept, γ_{01} and γ_{10} = fixed slopes and u_{0j} and u_{1j} = random effects at level-2.

Multicollinearity between the independent variables was assessed for each objective by using variance inflation factors (VIF >10 was considered as suggestive of existence of collinearity). Whenever multicollinearity existed, one of them was dropped from the model in turn. In addition, cross-level and individual-level two-way interactions were checked before interpreting the findings.

To ascertain the causes of neonatal death, the verbal autopsies were interpreted by two independent experienced paediatricians, who had been interpreting the V/A of Gilgel Gibe Field Research Centre of Jimma University. In cases of disagreement, a third paediatrician was contacted and interpreted.

The qualitative data were listened carefully and transcribed in English language. Then, each important term were coded and tallied, which later used to create categories. Then, themes were created from the categories based on the objectives of the study. Finally, the findings were triangulated with the quantitative one. Narration and striking quotations were used to present the findings.

3.9. Ethical clearance

Before the commencement of the data collection, necessary ethical clearances were obtained from responsible bodies. First, the proposal was reviewed and approved by the Research Review and Ethics Committee (REC) of the School of Public Health of Addis Ababa University. Successively, ethical approval was obtained from the Institutional Review Board (IRB) of the College of Health Sciences of the University. Then, it was further reviewed and approved by the IRB of the Oromia Regional State Health Bureau. Following this, formal letters and permissions were secured from all respective local administrators.

Written informed consent was obtained from each respondent before actual data collection after reading the information sheet in local language. Issues of confidentiality were maintained by removing any identifiers from the questionnaire and the right to refuse or withdraw at any time was respected. To protect vulnerable groups such as sick neonates and mothers with any health problems, data collectors were trained to maintain confidentiality and provide necessary health information based on the need of the participants, including referral arrangements.

3.10. Operational definitions

- ***Attitude towards birth preparedness and complication readiness*:** Eight questions were asked on the attitude in a Likert-scale and composite score was produced by PCA. Mothers who scored above or equal to the mean score were labelled as "favourable attitude" and otherwise "unfavourable attitude".
- ***Birth preparedness and complication readiness practice:*** a package of interventions measured as a composite variable of 5 items: planed to save money, planed to arrange transport, planed to give birth in health facility, planed to be attended by skilled attendant and planed to arrange blood donor. Those mothers who fulfilled three or more of the five items were considered as ‗well prepared' and otherwise ‗not well prepared.'
- ***Danger signs:*** signs/symptoms that suggest obstetric complications and easily identified by non-clinical personnel (e.g. mother)

- ***Key danger signs during labour and childbirth:*** refers to four symptoms, namely Severe vaginal bleeding, prolonged labour (>12 hours), convulsions and retained placenta (>30minutes after the expulsion of fetus). In this study, those mothers who spontaneously mentioned all the 4 key danger signs were rated as knowledgeable and otherwise not.
- ***Key danger signs during pregnancy:*** refers to three symptoms, namely severe vaginal bleeding, swollen hands/face and blurred vision. Mothers who spontaneously mentioned all the 3 key danger signs were rated as knowledgeable and otherwise not in this study.
- ***Key danger signs during the postpartum period:*** refers to three symptoms namely severe vaginal bleeding, foul-smelling vaginal discharge and high fever. Mothers who spontaneously mentioned all the 3 key danger signs were rated as knowledgeable and otherwise not in this study.
- ***Key danger signs in the newborn:*** refers to four symptoms namely convulsions/spasms/rigidity, difficult/fast breathing, very small baby and lethargy/unconsciousness. Mothers who spontaneously mentioned all the 4 key danger signs were rated as knowledgeable and otherwise not in this study.
- ***Knowledge on community resources:*** community resources in this study included knowledge on whether their community has a financial support system, transportation system and blood donation system or not. Those women who knew the availability of all the three community resources were labelled as knowledgeable and otherwise not.
- ***Good cord care:*** use of a clean cutting instrument to cut the umbilical cord **plus** clean thread to tie the cord **plus** no substance applied to the cord
- ***Appropriate neonatal breastfeeding:*** initiating breastfeeding within the first one hour after birth **plus** baby given no supplements at all in the first month of life.
- ***Neonatal care practice:*** composite score (index) of 12 questions adapted from the minimum neonatal care package of WHO. All the 12 questions had response categories of ‗Yes' or ‗No', then the score of ‗1' was given for ‗Yes' or appropriate practice and ‗0' was given for ‗No' or inappropriate practice. Then total score (index) for each respondent was determined by using PCA. Then, mean score was determined and mothers scoring above or equal to the mean score were labelled as having ―Good neonatal care practice" and otherwise ―Poor neonatal care practice."
- ***Optimal thermal care:*** baby put skin-to-skin contact with mother at birth **or** wrapped at birth with clean cloth **plus** first bath after 6 or more hours.

Table 3. Summary of the methods of the study, Jimma Zone, Southwest Ethiopia, Sept 2012- Dec 2013.

Objectives	Design	Methods	Data collection methods	Study population (respondents)	Sample size *	Data Analysis
1. To determine the status of Birth preparedness and complication readiness and affecting factors	Cross-sectional	Quantitative	Interview administered questionnaire	Pregnant Women	1610 1650	Multilevel logistic regression
		Qualitative	In-depth Interview	Family members (4), TBAs (4) and HEWs (4)	12	Thematic analysis
			FGD	Pregnant women	6	
2. To assess the status of skilled care use and determine the effect of BP and CR on skilled care use	Prospective follow-up	Quantitative	Interview administered questionnaire	Mothers who had been on follow up and gave live births (Just at the end of neonatal period: 28-42 days)	1902 2603	Multilevel logistic regression
		Qualitative	In-depth Interview	Health workers (4) TBAs (4) HEWs (4)	12	Thematic analysis
			FGD	Mothers having neonates of 1-6 months of age	6	
3. To assess the status of neonatal care practice and identify affecting factors	Prospective follow-up	Quantitative	Interview administered questionnaire	Mothers who had been on follow up and gave live births (Just at the end of neonatal period: 28-42 days)	1934 2284	Multilevel linear regression
		Qualitative	In-depth Interview	Health workers (4), TBAs (4) and HEWs (4)	12	Thematic analysis
			FGD	Mothers having infants of 1-6 months of age	6	
4. To determine the status of neonatal mortality and identify causes and determinants	Prospective follow-up	Quantitative	Interview administered questionnaire	Mothers who had been on follow up and gave live births (Just at the end of neonatal period: 28-42 days)	3090 **3604**	Multilevel logistic regression
			Verbal autopsy	Mothers whose neonates were died or care givers	All neonatal deaths (110)	Interpretation by two paediatricians

**The first sample size is for the status and the second sample is for the factors.*

4. RESULTS

4.1. Response rate

The minimum sample size required for the study was 3604 mothers with their neonates. However, due to the cluster sampling nature of the design, a total of, 3696 pregnant women were obtained from the selected 73 clusters and all were considered for the study. From these, 14 were not interviewed at the baseline, as 6 left the study area and 8 gave birth before interview. As a result, 3682 were interviewed at the baseline and 3612 were included in the analysis after excluding 70 incomplete or inconsistent questionnaires. After excluding, spontaneous abortions, maternal death during pregnancy and loss-to-follow up, 3474 total deliveries were recorded. Finally, after excluding 47 stillbirths and including 38 twin births, 3463 live births were obtained and included in the final analysis making a response rate of 95.9% (Figure 4).

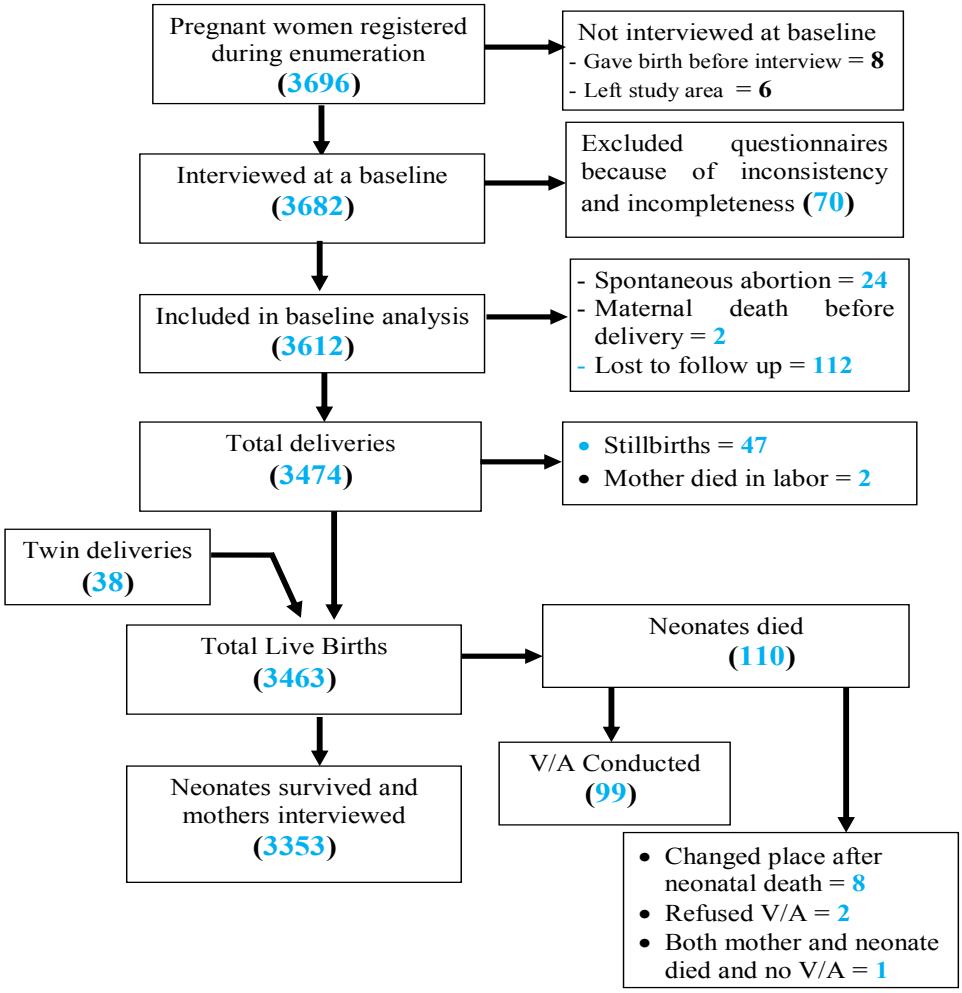

Figure 4. Flow-diagram of the overall study process, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013.

4.2. Baseline socio-demographic characteristics

Of the total 3612 pregnant women included in the analysis at the baseline, 2716 (75.2%) were rural residents. Majority, 2323 (64.3%), belonged to the age group of 20-29 years with a mean (±SD) of 26.5±5.0. Oromo was the predominant ethnic group, 3161 (87.7%). The leading religion was Muslim, 3149 (87.1%). Nearly all, 3589 (99.4%) were in a marital union and more than half, 1955 (54.1%) had not attended any formal education. The great majority, 3413 (94.5%), were housewives and farming was the leading occupation of their partners, 2566 (71.0%) (Table 4).

Table 4. Selected Socio-demographic characteristics of respondents, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3612)

Variables	No.	%
Place of residence		
Urban	896	24.8
Rural	2716	75.2
Age (Years)		
15-19	179	5.0
20-24	1023	28.3
25-29	1300	36.0
30-34	766	21.2
35-39	311	8.6
40-44	33	0.9
Ethnicity		
Oromo	3161	87.7
Amhara	175	4.8
Dawuro	102	2.8
Others*	174	4.7
Religion		
Muslim	3149	87.1
Orthodox	360	10.0
Protestant	103	2.9
Marital Status		
In marital union	3589	99.4
Not in marital union†	23	0.6
Educational status		
No formal education	1955	54.1
First cycle primary (Grades 1-4)	843	23.3
Second cycle primary (Grades 5-8)	479	13.3
Secondary (Grades 9-12)	265	7.3
Tertiary (12^{+})	70	1.9
Occupation		
Housewife	3413	94.5
Employed (GO, NGO and Private)	88	2.4
Others‡	111	3.1
Husband's Occupation		
Farmer	2566	71.0
Employed (GO, NGO and Private)	398	11.1
Merchant	421	11.7
Others‡	227	6.2

**Yem, Kaficho, Guraghe or Tigrie, † Single, divorced or widowed, ‡Merchant, student or daily labourer*

4.3. Birth preparedness and complication readiness and affecting factors (Paper-II)

4.3.1. Knowledge of key danger signs and attitude towards BP and CR

The key obstetric danger signs were assessed by women's own spontaneous responses. Accordingly, the three key danger signs during pregnancy: severe vaginal bleeding, swollen hands/face and blurred vision were mentioned by 964 (26.7%), 530 (14.7%) and 1078 (29.8%), respectively. However, only 227 (6.3%) spontaneously mentioned all the three key danger signs. The four key danger signs during labour and delivery: severe vaginal bleeding, convulsions, prolonged labour and retained placenta were spontaneously mentioned by 1788 (49.5%), 588 (16.3%), 537 (14.9%) and 545 (15.1%), respectively. Very few, 133 (3.7%), mentioned all the four key danger signs spontaneously.

The three key danger signs during postnatal period: severe vaginal bleeding, foul smelling vaginal discharge and high fever were spontaneously mentioned by 1638 (45.3%), 548 (15.2%), and 436 (12.1%), respectively. However, only 88 (2.4%) were able to mention the three key danger signs spontaneously. The four key danger signs of neonates: difficult or fast breathing, small at birth, lethargy/unconscious and seizure/convulsion were spontaneously mentioned by 1483 (41.1%), 675 (18.7%), 377 (10.4%) and 243 (6.7%), respectively. While, only 75 (2.1%) were able to mention the four key danger signs.

Attitude of the respondents was measured by using a composite variable of eight items in a Likert-scale and attitude score was developed by PCA. Then, mothers, who scored above or equal to the mean score were rated as having favourable attitude. Based on this, 2202 (61.0%) were found to have favourable attitude towards BP and CR (Table 5).

4.3.2. Birth preparedness and complication readiness practice

Among the five elements of BP and CR practice, 2656 (73.5%) planned to save money, 2174 (60.2%) planned to arrange transport, 719 (19.9%) planned to prepare blood donor, 1169 (32.4%) planned to give birth in health facility and 791 (21.9%) planned to be attended by skilled attendant for their pregnancy. By considering three or more steps of the five parameters, 1245 (34.5%) were found to fulfil the criteria and rated as well prepared. However, after weighted analysis to avoid urban over representation and over estimation, the final status of BP and CR was found to be 23.3% (95% CI: 21.8%, 24.9%) (Table 6).

Table 5. Knowledge of key danger signs and attitude towards birth preparedness and complication readiness among the respondents, Jimma Zone, Southwest Ethiopia, Sep 2012-Dec 2013.

Variables	No.	%
Knowledge of key danger signs during pregnancy (multiple responses)		
Severe vaginal bleeding	964	26.7
Swollen hands/face	530	14.7
Blurred vision	1078	29.8
Knowledge of key danger signs during labour and delivery (multiple responses)		
Severe vaginal bleeding	1788	49.5
Convulsions	588	16.3
Prolonged labour	537	14.9
Retained placenta	545	15.1
Knowledge of key danger signs during postnatal period (multiple responses)		
Severe vaginal bleeding	1638	45.3
Foul smelling vaginal discharge	548	15.2
High fever	436	12.1
Knowledge of key danger signs during neonatal period (multiple responses)		
Difficult or fast breathing	1483	41.1
Small at birth	675	18.7
Lethargy/unconscious	377	10.4
Seizure/convulsion	243	6.7
Attitude towards birth preparedness and complication readiness		
Favourable attitude (above or equal to mean score)	2202	61.0
Unfavourable attitude (less than mean score)	1410	39.0

Table 6. Birth preparedness and complication readiness practice among the respondents, Jimma Zone, Southwest Ethiopia, Sep 2012-Dec 2013.

Variables	Number (n=3612)	Unweighted %	Weighted %
Components of BP and CR practice			
Planed to save money	2656	73.5	69.1
Planed to arrange mode of transport	2174	60.2	56.1
Planed to arrange blood donor	719	19.9	17.5
Planed to give birth in health facility	1169	32.4	17.9
Planed to be attended by skilled attendant	791	21.9	14.5
Number of steps taken			
< 3 (Poor preparation)	2367	65.5	76.7
≥ 3 (Good preparation)	1245	34.5	23.3

4.3.3. Factors affecting birth preparedness and complication readiness

The factors affecting birth preparedness and complication readiness were identified by using mixed-effects multilevel logistic regression model. Before running the full model, ICC (ρ) was calculated in the empty model and it was found to be 0.554 indicating that 55.4% of the variation was contributed by between cluster variation. The test of the preference of log likelihood Vs logistic regression was also strongly significant (P<0.001). Then, the full model was run by including both the cluster level and individual level variables and the ICC (ρ) was reduced to 0.302. This again indicated that 30.2% of the variation was attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood Vs logistic regression was again strongly significant (P<0.001) (Table 7).

Table 7. Parameter coefficients and test of goodness-of-fit of the mixed-effects multilevel models, Jimma Zone, Southwest Ethiopia, September 2012-December 2013.

Models	Fixed intercept -cons(95%CI)	Random effect as Level-2 variance var(-cons (95%CI))	Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR)-deviance	Significance of LR test Vs Logistic regression (P-value)
Objective 1: BP and CR practice					
Empty model	0.60 (0.38, 0.96)	4.09 (2.82, 5.93)	0.554 = 55.4%	-1599.82	< 0.0001
Full model	0.03 (0.01, 0.06)	1.42 (0.94, 2.13)	0.302 = 30.2%	-1447.60	< 0.0001
Objective 2: Skilled care use					
Empty model	-0.71 (-1.13, -0.30)	3.15 (2.18, 4.56)	0.489 = 48.9%	-1614.54	< 0.0001
Full model	0.07 (0.04, 0.14)	0.42 (0.25, 0.69)	0.113 = 11.3%	-1584.68	< 0.0001
Objective 3: Neonatal care					
Empty model	0.25 (0.01, 0.49)	1.02 (0.72, 1.44)	0.332 = 33.2%	-6269.60	< 0.0001
Full model	-0.30 (-0.69, 0.09)	0.36 (0.25, 0.51)	0.157 = 15.7%	-6143.08	< 0.0001
Objective 4: Neonatal mortality					
Empty model	-3.63 (-3.92, -3.34)	0.34 (0.14, 0.86)	0.100 = 10.0%	-481.92	0.0003
Full model	-7.27 (-9.71, -4.83)	0.69 (0.27, 1.76)	0.174 = 17.4%	-325.61	0.0001

After adjusting for confounders in the final two-levels mixed effects model, among the cluster level variables, place of residence and access to health centre were found to have statistically significant association with BP and CR practice. Women from urban residence (OR = 6.01; 95%CI: 2.56, 14.08) and women who were from *Kebele*s found within 2 hours

travel on foot from health centre in average (OR = 2.93; 95%CI: 1.43, 6.02) were more likely to be prepared for birth and its complications.

Among the socio-demographic and economic characteristics considered as level 1, educational status, husband‘s occupation and wealth quintiles were found to have statistically significant association with BP and CR practice. Women who attended primary (OR=1.55; 95%CI: 1.24, 1.94), secondary (OR=3.13; 95%CI: 2.00, 4.91) or tertiary educations (OR=8.04; 95%CI: 2.14, 30.24) were more likely to be prepared as compared to women who had not attended any formal education. Women having husbands, who were employed (OR= 1.77; 95%CI: 1.14, 2.74) or merchant (OR=2.04; 95%CI: 1.40, 2.96) were more likely to be prepared as compared to women having farmer husbands. Women in the better wealth status such as third (OR=1.46; 95%CI: 1.06, 2.00), fourth (OR=1.24; 95%CI: 1.06, 1.72) or fifth (OR=1.56; 95%CI: 1.12, 2.19) quintiles were more likely to be prepared as compared to women in the lowest quintiles (poorest).

Among the obstetric related factors considered at individual level, knowledge of key danger signs, attitude towards BP and CR and frequency of ANC visits had significant association with BP and CR practice. Women who knew all the four key danger signs during labour and delivery were more likely to be prepared for birth and its complications (OR=2.04; 95%CI: 1.22, 3.39). Similarly, having favourable attitude towards BP and CR was found to increase the likelihood of preparation significantly (OR = 1.73; 95%CI: 1.37, 2.18). Antenatal care visit was also among the strong predictors of BP and CR. Having 1-3 visits (OR = 2.12; 95%CI: 1.67, 2.69) and greater or equal to 4 visits (OR=2.87; 95%CI: 1.98, 4.18) were found to increase the likelihood of preparation significantly as compared to those who did not attend ANC visit at all (Table 8).

Table 8. Multilevel analysis of factors affecting birth preparedness and complication readiness, among respondents, Jimma Zone, Southwest Ethiopia, September 2012- December 2013.

Factors	BP and CR Practice			Crude OR (95%CI)	Adjusted OR (95%CI)
	Well prepared (n=1245) n (%)	Not well prepared (n=2367) n (%)	Total (n=3612) n (%)		
Level-2 (Higher level) Variables					
Place of residence					
Rural	580 (21.4)	2136 (78.6)	2716 (100.0)	1.00	1.00
Urban	665 (74.2)	231 (25.8)	896 (100.0)	10.60 (8.90, 12.64)	6.01 (2.56, 14.08)
Average distance from health centre (on foot)					
≤2 hours	1108 (42.9)	1472 (57.1)	2580 (100.0)	4.92 (4.04, 5.98)	2.93 (1.43, 6.02)
>2 hours	137 (13.3)	895 (86.7)	1032 (100.0)	1.00	1.00
Average distance from Hospital (on foot)					
≤2 hours	359 (71.4)	144 (28.6)	503 (100.0)	6.25 (5.08, 7.71)	0.95 (0.37, 2.44)
>2 hours	886 (28.5)	2223 (71.5)	3109 (100.0)	1.00	1.00
Level-1 variables: Socio-demographic and economic characteristics					
Age (in years)					
<20	76 (42.5)	103 (57.5)	179 (100.0)	1.00	1.00
20-29	848 (36.5)	1475 (63.5)	2323 (100.0)	0.78 (0.57, 1.06)	1.02 (0.64, 1.62)
≥30	321 (28.9)	789 (71.1)	1110 (100.0)	0.55 (0.40, 0.76)	1.96 (0.69, 1.96)
Ethnicity					
Oromo	956 (30.2)	2205 (69.8)	3161 (100.0)	1.00	1.00
Others	289 (64.1)	162 (35.9)	451 (100.0)	4.12 (3.35, 5.06)	0.99 (0.66, 1.50)
Religion					
Muslim	933 (29.6)	2216 (70.4)	3149 (100.0)	1.00	1.00
Others	312 (67.4)	151 (32.6)	463 (100.0)	4.91 (3.98, 6.05)	1.25 (0.82, 1.91)
Educational status					
No Formal Education	438 (22.4)	1517 (77.6)	1955 (100.0)	1.00	1.00
Primary (1-8)	541 (40.9)	781 (59.1)	1322 (100.0)	2.40 (2.06, 2.80)	1.55 (1.24, 1.94)
Secondary (9-12)	201 (75.8)	64 (24.2)	265 (100.0)	10.88 (8.05, 14.69)	3.13 (2.00, 4.91)
Tertiary (12^{+})	65 (92.9)	5 (7.1)	70 (100.0)	45.03 (18.02, 112.51)	8.04 (2.14, 30.24)
Occupation					
House wife	1097 (32.1)	2316 (67.9)	3413 (100.0)	1.00	1.00
Employed	74 (84.1)	14 (15.9)	88 (100.0)	11.16 (10.28, 19.85)	0.79 (0.32, 2.08)
Others	74 (66.7)	37 (33.3)	111 (100.0)	4.22 (2.83, 6.31)	0.81 (0.45, 1.46)
Occupation of Husband					
Farmer	538 (21.0)	2028 (79.0)	2566 (100.0)	1.00	1.00
Employed	306 (76.9)	92 (23.1)	398 (100.0)	12.54 (9.75, 16.13)	1.77 (1.14, 2.74)
Merchant	281 (66.7)	140 (33.3)	421 (100.0)	7.57 (6.05, 9.47)	2.04 (1.40, 2.96)
Others	120 (52.9)	107 (47.1)	227 (100.0)	4.23 (3.20, 5.58)	1.15 (0.71, 1.85)
Wealth quintiles					
1^{st} Quintile (poorest)	157 (21.7)	565 (78.3)	722 (100.0)	1.00	1.00
2^{nd} Quintile	249 (34.4)	474 (65.6)	723 (100.0)	1.89 (1.50, 2.41)	1.23 (0.90, 1.68)
3^{rd} Quintile	250 (3.6)	472 (65.4)	722 (100.0)	1.91 (1.51, 2.41)	1.46 (1.06, 2.00)
4^{th} Quintile	255 (35.3)	468 (64.7)	723 (100.0)	1.96 (1.55, 2.48)	1.24 (1.06, 1.72)
5^{th} Quintile (richest)	334 (46.3)	388 (53.7)	722 (100.0)	3.10 (2.46, 3.90)	1.56 (1.12, 2.19)

Table 8. Multilevel analysis of factors affecting birth preparedness and complication readiness ...(continued)

Level-1: Obstetric related variables					
Knowledge of key danger signs during pregnancy					
Not knowledgeable	1139 (33.6)	2246 (66.4)	3385 (100.0)	1.00	1.00
Knowledgeable	106 (46.7)	121 (53.3)	227 (100.0)	1.73 (1.32, 2.26)	1.24 (0.83, 1.84)
Knowledge of key danger signs during labour					
Not knowledgeable	1169 (33.6)	2311 (66.4)	3480 (100.0)	1.00	1.00
Knowledgeable	76 (57.6)	56 (42.4)	132 (100.0)	2.68 (1.89, 3.82)	2.04 (1.22, 3.39)
Knowledge of key danger signs during post natal period					
Not knowledgeable	1198 (34.0)	2326 (66.0)	3524 (100.0)	1.00	1.00
Knowledgeable	47 (53.4)	64 (46.6)	88 (100.0)	2.23 (1.46, 3.40)	1.67 (0.89, 3.12)
Knowledge of key danger signs of neonates					
Not knowledgeable	1200 (33.9)	2337 (66.1)	3537 (100.0)	1.00	1.00
Knowledgeable	45 (60.0)	30 (40.0)	75 (100.0)	2.91 (1.83, 4.66)	1.10 (0.60, 2.04)
Attitude toward BP and CR					
Unfavourable attitude	337 (23.9)	1073 (76.1)	1410 (100.0)	1.00	1.00
Favourable attitude	908 (41.2)	1294 (58.8)	2202 (100.0)	2.23 (1.93, 2.60)	1.73 (1.37, 2.18)
Gravida					
Primi	375 (47.8)	410 (52.2)	785 (100.0)	1.00	1.00
2-4	664 (35.0)	1234 (65.0)	1898 (100.0)	0.58 (0.50, 0.70)	0.88 (0.67, 1.16)
>4	206 (22.2)	723 (77.8)	929 (100.0)	0.31 (0.25, 0.38)	0.72 (0.51, 1.03)
ANC Visit					
Not at all	182 (15.4)	996 (84.6)	1178 (100.0)	1.00	1.00
1-3 times	870 (41.4)	1229 (58.6)	2099 (100.0)	3.87 (3.24, 4.64)	2.12 (1.67, 2.69)
≥4 times	193 (57.6)	142 (42.4)	335 (100.0)	7.44 (5.69, 9.73)	2.87 (1.98, 4.18)

4.3.4. Findings of the qualitative method

The qualitative part tried to have in-depth investigation of the factors affecting BP and CR practice. The findings supplemented the quantitative one and categorized under the following themes: low risk perception, distance and transport, socio-economy, work situation and low males (husbands) involvement.

Low risk perception

Majority of the respondents mentioned that low level of awareness and low risk perceptions were among the barriers for preparing for birth and its complication by pregnant women. As they explained, most pregnant women do not perceive that they face problems and do not know what to prepare beyond food and the materials needed for home delivery. Even those who know have the perception that women need preparation if problems are faced.

A 24 years old pregnant women (FGD discussant) said, *"...I didn"t follow ANC for my previous pregnancy as well as current pregnancy. I gave my last child at home and faced no problem. This is what all women do. So, why should I prepare myself unless I face problems? It is the God/Allah to do this…."*

Distance and transport

Most of the participants emphasized the issues of transportation as a major problem particularly as a barrier for service use plan. As they mentioned, currently, in urban areas, Red-Cross Association's ambulance and *Bajaj*' have been playing a great role for those who have money to pay and phone to call. However, in rural areas, mothers could not go even for complicated labour and treatment if get ill let alone ANC visit being well.

Low socio-economy and work situation

As majority agreed, women in rural areas are at low socio-economic status. Because of this, they give attention to their daily activity for family survival and do not give much attention to their health issues. Most of them stressed that to save money, use ANC and prepare themselves for delivery, mothers must have money.

A 28 years old FGD participant stated, *"....there was my neighbourhood who was pregnant. She was poor and had not saved money. She faced prolonged labour and we called ambulance, but could not get. We called a minibus and the driver asked 500 Birr (USD 25), which the family could not afford. Finally, she gave dead foetus and hardly survived while carrying to health centre…"*

Low male involvement

Males, particularly husbands, have a great role to play in helping mothers to prepare for birth and its complication. However, as most participants explained, this has been practiced by few husbands in urban areas. However, in rural areas, most males do not know that they are part of the preparation. Even those who do know do not give attention.

A 36 years old community leader said, *"...most husbands do not give attention and priority to the health condition of their partners. They don"tgive money for health care; rather they prefer to chew chat and drink alcohols…"*

4.4. Skilled care use and determinant factors (Paper-III)

4.4.1. Skilled care use during pregnancy and delivery

As this study was a follow up study, after excluding spontaneous abortions, maternal deaths and loss to follow up, 3472 deliveries were included in the analysis to determine the status of skilled care use and determinant factors.

Of the 3472 respondents, 2634 (75.9%) had at least one ANC visit during pregnancy and 1830 (52.7%) had used either from hospital or health centre attended by skilled attendant. However, only 1228 (35.4%) had 4 or more visits and 572 (16.5%) started during first trimester. Of the respondents, 1064 (30.6%) used skilled care during delivery (74.1% in urban and 16.5% in rural). However, the weighted coverage of skilled care use was much lower 17.5% (95% CI: 16.2%, 18.8%). The major reasons for giving birth in hospital or health centre were pre-planed (43.5%), need skilled attendant (41.0%), problem during labour (28.9%) and need clean/safe place (15.1%). Whereas, the most common reason for home delivery was lack of transport (31.1%) followed by the perception that home delivery is the usual place (24.0%) and more comfortable (23.1%) (Table 9).

4.4.2. Relation between intention and skilled care use

One thousand eight hundred fifty eight (53.5%) mothers had planned to have 4 or more ANC visits from skilled attendants. However, only 1228 (35.4%) actually had 4 or more ANC visits. Using 4 or more ANC visits was 46.0% among those who planned to have it as compared to 23.2% among who didn‘t plan, which was statistically significant (COR=2.68; 95%CI: 2.39, 3.02). Similarly, 1136 (32.7%) had planned to use skilled care during labour and 1064 (30.6%) actually used it. About 61.7% of those who had already planed actually used as compared to only 15.5% of those who didn‘t plan, which was significantly higher (COR=1.20; 95% CI: 1.04, 1.38).

Four hundred thirty-five (38.3%) of those who had already planned to use skilled care did not use it actually. The main reasons were the labour was not associated with problems 382 (87.8%), lack of transport 64 (14.7%) and lack of money for transport and services 58 (13.3%). On the other hand, 363 (15.5%) of those who did not plan to use skilled care actually used it. The main reason was occurrence of unanticipated problems at labour 174 (47.9%) among which prolonged labour was the leading one 152 (41.9%). The other reason was family insisted at labour to have safe and clean delivery 99 (27.3%). This indicated that intention significantly implies action in skilled care use; however, not 100% as complication during labour is unpredictable (Table 10).

Table 9. Skilled care use during pregnancy and delivery among respondents, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3472).

Variables	No.	Unweighted %	Weighted %
ANC (at least once)			
Yes	2634	75.9	72.2
No	838	24.1	27.8
Place of ANC (n=2634)			
Hospital	145	5.5	1.2
Health Centre	1585	60.2	55.5
Private clinic/FGAE	100	3.8	0.7
Health post	804	30.5	42.6
Attendant of ANC (n=2634)			
Skilled attendant§	1830	69.5	57.4
HEW	804	30.5	42.6
Number of ANC visit (n=2634)			
1-3	1406	53.4	61.7
≥4	1228	46.6	38.3
GA at ANC start (n=2634)			
1st trimester	572	21.7	16.3
2nd trimester	1771	67.2	72.0
3rd trimester	291	11.0	11.7
Place of delivery			
Hospital	425	12.2	6.4
Health Centre	573	16.5	10.7
Private clinic/FGAE	66	1.9	0.4
Health Post	48	1.4	1.8
Home/TBA's Home	2360	68.0	80.7
Delivery attendant			
Skilled attendants§	1064	30.6	17.5
HEW	59	1.7	2.2
Family/TBA	2349	67.7	80.3
Mode of delivery			
SVD	3336	96.1	96.8
C/S	80	2.3	1.5
Assisted	56	1.6	1.7
Reasons for health facility delivery (n=1112, multiple responses)			
Pre-planned	484	43.5	
Need skilled attendant	456	41.0	
Problem during labour	321	28.9	
Need clean/safe place	168	15.1	
Reasons for home delivery (n=2360, multiple responses)			
Lack of transport	735	31.1	
Home delivery is my usual place	567	24.0	
Home delivery is more comfortable	546	23.1	
Lack of money for transport	289	12.2	
Lack of money for service cost	142	6.0	

§ Doctor, nurse, midwife, HO, unspecified health workers

Table 10. Intention versus action in skilled care use during pregnancy and childbirth and reasons among respondents, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3472).

Plan(intention)	Actual practice (Action)			P-value
	Had ≥ 4 ANC Visit			
Planed ≥ 4 ANC Visit	**Yes n(%)**	**No n(%)**	**Total n(%)**	
Yes	854 (46.0)	1004 (54.0)	1858(53.5)	P < 0.001
No	374 (23.2)	1240 (76.8)	1614(46.5)	(OR=2.68; 95%CI: 2.39, 3.02)
Total	1228 (35.4)	2244 (64.6)	3472(100.0)	
Planned to use skilled care during delivery	**Used skilled care during delivery**			
	Yes n(%)	**No n(%)**	**Total n(%)**	
Yes	701 (61.7)	435 (38.3)	1136 (32.7)	P = 0.01
No	363 (15.5)	1973 (84.5)	2336 (67.3)	(COR=1.20; 95%CI: 1.04, 1.38)
Total	1064 (30.6)	2408 (69.4)	3472 (100.0)	

Reasons for not using skilled care once planed (n=435, multiple responses)	**No.**	**%**
Labour not associated with problems	382	87.8
Lack of transport	64	14.7
Lack of money	58	13.3
Reasons for using skilled care which was not planed (n=363, multiple responses)		
Any problem encountered during labour	174	47.9
Prolonged labour (>12 hours)	152	41.9
Family insisted at labour to have safe delivery	99	27.3

4.4.3. Determinants of skilled care use

The determinants of skilled care use were identified by using mixed-effects multilevel logistic regression model. To evaluate the applicability of this model, the Intra-class Correlation Coefficient (ICC (ρ)) was calculated in the empty-model and it was found to be 0.489 indicating that 48.9% of the variation was contributed by between cluster variations. The test of the preference of log likelihood versus logistic regression was also strongly significant (P<0.0001). Then, the full model was run by including all the cluster level and individual level variables and the ICC (ρ) became 0.113 indicating that 11.3% of the variation was attributed to cluster level variables again suggesting the preference of multilevel analysis. The preference of the log likelihood versus logistic regression was still strongly significant (P<0.0001) (Table 7).

After adjusting in the final two-level mixed-effects logistic regression model, factors affecting skilled care use existed both at the cluster level and at the individual level. Among the higher (cluster) level variables, place of residence and access to BEmOC were found to have statistically significant association with skilled care use. Women in urban areas were more than two times more likely to use skilled care as compared to rural women (OR=2.38;

95%CI: 1.74, 3.24). Similarly, women in clusters having BEmOC (health centre) within 2 hours distance on foot in average were more likely to use skilled care (OR=1.61; 95%CI: 1.12, 2.33). However, having CEmOC (hospital) within 2 hours distance on foot in average had non-significant effect on skilled care use (OR=1.36; 95%CI: 0.74, 2.51).

Among the lower (individual) level variables, maternal education, husband's occupation, wealth quintiles, gravida, inter-birth interval, knowledge of key danger signs during labour, ANC visit and BP and CR were found to have statistically significant association with skilled care use. Having primary (OR=1.37; 95%CI: 1.10, 1.71), secondary (OR=3.48; 95%CI: 2.22, 5.45) or tertiary (OR=3.97; 95%CI: 1.38, 11.46) educations were found to increase the likelihood of skilled care use significantly as compared to not having formal education. Similarly, women whose husbands were employed (OR=3.26; 95%CI: 2.15, 4.94) or merchants (OR=2.27; 95%CI: 1.60, 3.23) were more likely to use skilled care as compared to those whose husbands were farmers. Women in the 3rd wealth quintiles (OR=1.73; 95%CI: 1.12, 1.84) and 4th quintiles (OR=1.28; 95%CI: 1.11, 1.73) were more likely to use skilled care as compared to those in the lowest quintile (poorest).

Number of pregnancies and inter-birth interval were among the individual level obstetric factors found to have significant association with skilled care use. Mothers with experience of 1-4 pregnancies (OR= 0.41; 95%CI: 0.26, 0.66) and 5 or more (OR= 0.45; 95%CI: 0.26, 0.76) were less likely to use skilled care as compared to primi-gravida mothers. Inter-birth interval of >48 months was found to increase the likelihood of skilled care use as compared to interval of <24 months (OR=2.18; 95%CI: 1.30, 3.63).

Knowledge of key danger signs during labour was the other determinant of skilled care use. Women who knew 3 or more key danger signs during labour were more likely to use skilled care as compared to those who did not know any key danger signs (OR=1.59; o5%CI: 1.05, 2.43). Similarly, having 1-3 ANC visits (OR=1.63; 95%CI: 1.23, 2.18) and ≥4 visits (OR= 3.10; 95%CI: 2.31, 4.16) during pregnancy increased the likelihood of skilled care use significantly. After controlling all the necessary variables in the mixed-effects multilevel model, birth preparedness and complication readiness plan had significant effect on skilled care use. Women who were well-prepared during pregnancy were more likely to use skilled care as compared to those who were not well-prepared (OR=1.32; 95%CI: 1.03, 1.68) (Table 11).

Table 11. Multilevel analysis of factors associated with skilled care use among respondents, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3472).

Factors	Skilled care use			Crude OR (95%CI)	Adjusted OR (95%CI)
	Skilled care (n=1064) n (%)	Non-skilled care (n=2408) n (%)	Total (n=3472) n (%)		
Leve-2 (communal) variables					
Place of residence					
Rural	431 (16.5)	2187 (83.5)	2618 (100.0)	1.00	1.00
Urban	633 (74.1)	221 (25.9)	854 (100.0)	14.49 (12.05, 17.54)	2.38 (1.74, 3.24)
Distance from Health centre (on foot)					
≤ 2hours	917 (37.5)	1531 (62.5)	2448 (100.0)	3.57 (2.95, 4.33)	1.61 (1.12, 2.33)
>2hours	147 (14.4)	877 (85.6)	1024 (100.0)	1.00	1.00
Distance from Hospital (on foot)					
≤ 2hours	356 (73.7)	127 (26.3)	483 (100.0)	9.03 (7.25, 11.25)	1.36 (0.74, 2.51)
>2hours	708 (23.7)	2281 (76.3)	2989 (100.0)	1.00	1.00
Leve-1 (individual level) variables-socio-demographic and economic					
Age (in years)					
<20	77 (44.3)	97 (55.7)	174 (100.0)	1.00	1.00
20-29	740 (33.2)	1487 (66.8)	2227 (100.0)	0.63 (0.46, 0.86)	1.32 (0.85, 2.07)
≥30	247 (23.1)	824 (76.9)	1071 (100.0)	0.38 (0.27, 0.53)	1.34 (0.80, 2.23)
Ethnicity					
Oromo	775 (25.5)	2266 (74.5)	3041 (100.0)	1.00	1.00
Others	289 (67.1)	142 (32.9)	431 (100.0)	5.95 (4.79, 7.39)	1.21 (0.80, 1.84)
Religion					
Muslim	754 (24.9)	2278 (75.1)	3032 (100.0)	1.00	1.00
Others	310 (70.5)	130 (29.5)	440 (100.0)	7.20 (5.78, 8.98)	1.33 (0.88, 2.04)
Educational status					
No Formal Education	341 (18.1)	1538 (81.9)	1879 (100.0)	1.00	1.00
Primary (1-8)	454 (35.7)	818 (64.3)	1272 (100.0)	2.50 (2.12, 2.95)	1.37 (1.10, 1.71)
Secondary (9-12)	208 (81.6)	47 (18.4)	255 (100.0)	19.96 (14.24, 27.98)	3.48 (2.22, 5.45)
Tertiary (>12)	61 (92.4)	5 (7.6)	66 (100.0)	55.03 (24.94,137.97)	3.97 (1.38, 11.46)
Occupation					
House wife	928 (28.2)	2361 (71.8)	3289 (100.0)	1.00	1.00
Employed	72 (88.9)	9 (11.1)	81 (100.0)	20.35 (10.14, 40.87)	0.84 (0.30, 2.31)
Others	64 (62.7)	38 (37.3)	102 (100.0)	4.28 (2.85, 6.45)	0.83 (0.48, 1.44)
Occupation of Husband					
Farmer	371 (15.0)	2102 (85.0)	2473 (100.0)	1.00	1.00
Employed	303 (81.2)	70 (18.8)	373 (100.0)	24.39 (18.52, 32.26)	3.26 (2.15, 4.94)
Merchant	267 (64.8)	145 (35.2)	412 (100.0)	10.42 (8.26, 13.16)	2.27 (1.60, 3.23)
Others	123 (57.5)	91 (42.5)	214 (100.0)	7.63 (5.71, 10.31)	1.50 (0.96, 2.32)
Wealth quartiles					
1st Quintile (poorest)	148 (21.8)	532 (78.2)	680 (100.0)	1.00	1.00
2nd Quintile	233 (33.0)	472 (67.0)	705 (100.0)	1.77 (1.39, 2.56)	1.20 (0.88, 1.64)
3rd Quintile	22 (32.0)	472 (68.0)	694 (100.0)	1.69 (1.32, 2.16)	1.73 (1.12, 1.84)
4th Quintile	217 (31.2)	478 (68.8)	695 (100.0)	1.63 (1.28, 2.08)	1.28 (1.11, 1.73)
5th Quintile (richest)	244 (35.0)	454 (65.0)	698 (100.0)	1.93 (1.52, 2.46)	1.09 (0.80, 1.48)

Table 11. Multilevel analysis of factors associated with skilled care use...(continued)

Factors	Skilled care use			Crude OR(95%CI)	Adjusted OR(95%CI)
	Skilled care (n=1064) n(%)	Non skilled care (n=2408) n(%)	Total(n=3472) n(%)		
Level-1 (Individual)-obstetric variables					
Gravida (# of pregnancies)					
Primi (1st)	377 (51.3)	358 (48.7)	735 (100.0)	1.00	1.00
2-4	531 (28.9)	1304 (71.1)	1835 (100.0)	0.39 (0.32, 0.46)	0.41 (0.26, 0.66)
>4	156 (17.3)	746 (82.7)	902 (100.0)	0.20 (0.16, 0.25)	0.45 (0.26, 0.76)
Inter-birth interval					
<24 Months	43 (17.1)	209 (82.9)	252 (100.0)	1.00	1.00
24-48 Months	489 (22.5)	1680 (77.5)	2169 (100.0)	1.42 (1.01, 1.99)	1.27 (0.83, 1.95)
>48 Months	155 (49.1)	161 (50.9)	316 (100.0)	4.68 (3.15, 6.95)	2.18 (1.30, 3.63)
Primi gravida	377 (51.3)	358 (48.7)	735 (100.0)	N/A	N/A
Knowledge of key danger signs during labour and delivery					
Not know any key danger sign	330 (24.2)	1031 (75.8)	1361 (100.0)	1.00	1.00
Know 1-2 key danger signs	607 (33.7)	1192 (66.3)	1799 (100.0)	1.59 (1.36, 1.86)	1.09 (0.86, 1.39)
Know 3-4 key danger signs	127 (40.7)	185 (59.3)	312 (100.0)	2.15 (1.66, 2.78)	1.59 (1.05, 2.43)
Knowledge of key danger signs of neonates					
Not know any key danger sign	414 (25.8)	1189 (74.2)	1603 (100.0)	1.00	1.00
Knows 1-2 key danger signs	570 (33.9)	1111 (66.1)	1681 (100.0)	1.47 (1.27, 1.71)	1.07 (0.85, 1.35)
Knows 3-4 key danger signs	80 (42.6)	108 (57.4)	188 (100.0)	2.13 (1.56, 2.90)	1.19 (0.71, 1.98)
No. of ANC Visit					
Not at all	110 (13.1)	728 (86.9)	838 (100.0)	1.00	1.00
1-3 times	321 (22.8)	1085 (77.2)	1406 (100.0)	1.96 (1.55, 2.48)	1.63 (1.23, 2.18)
≥4 times	633 (51.5)	595 (48.5)	1228 (100.0)	7.04(5.60, 8.86)	3.10 (2.31, 4.16)
BP and CR practice					
Not well prepared	425 (18.7)	1844 (81.3)	2269 (100.0)	1.00	1.00
Well prepared	639 (53.1)	564 (46.9)	1203 (100.0)	4.92 (4.21, 5.74)	1.32 (1.03, 1.68)

N/A=Not Applicable

4.4.4. Qualitative findings

The qualitative part tried to examine more in-depth factors affecting skilled care use. The findings supplemented the quantitative one. The commonly reported barriers to skilled care use were grouped under the following themes. Low awareness about the importance of skilled care use and low risk perception, lack of transport, cost of transport and services and perceived poor quality of care at the health facilities.

Low awareness and low risk perceptions

Majority of the respondents had the feeling that most of the women, particularly in the rural areas, are illiterate and have no adequate knowledge about the importance of giving birth in health facility attended by skilled attendants. The respondents also emphasized that the women have low risk perception that they expect as every labour goes normal and they go to give birth at health facility only if they face problems during labour.

Lack of transport and costs

The other major problems repeatedly raised by most of the respondents as barriers to skilled care use were unavailability of roads and means of transportation and costs of transportation and services.

A 36 years old TBA expressed her sorrow as, *"...many women face problem because of road and transportation unavailability. The community has been trying to carry women after complication in labour. Now, they are helping by burying women because of repeated occurrences and loss of hope…."*

A 30 years old FGD discussant added, *„ ...Lack of ambulance is our serious problem. I know one woman in my neighbourhood. She had labour at home for more than a day. We tried to take her to health facility, but no any car around. As a result, we had no options except waiting her till the dead fetus came out ...."*

Perceived quality of care:

Most of the key informants and FGD discussants had the view that most women have perceived poor quality of services that act as barriers to skilled care use. The most commonly encountered responses include, long waiting time, repeated card loss, the health workers do not threat respectfully, negligence, unnecessary procedures (P/V, episiotomy and C/S) and difficult to get senior doctors except students.

A 26 years old FGD discussant said, *"...I don"t think educated people are there in health centres. I had one pregnant sister who had bleeding at 9th month before labour. I took her to health centre, the nurses did pelvic examination many times, ordered her to be on coach again down repeatedly and said, ‚labour was started." After 10 hours, another nurse came and told me to take her home. Again, after three days, we took her to the health centre and they referred her to hospital. Finally, she hardly survived after delivering dead fetus in the car. I don't think I will go to that health facility again for delivery."*

Another 32 years old FGD discussant added, *"...currently almost students are working in the hospital and it is difficult to get experienced Doctors. As a result, all women going to hospital give birth with operation. Every woman, including me knows this. I never go to that hospital even if I face problem during my labour."*

4.5. Neonatal care practice and affecting factors (Paper-IV)

4.5.1. Status of neonatal care practice

From the 3612 mothers on follow up, a total 3463 live births happened and included in the analysis to determine the status of neonatal care and identify the affecting factors. Among the components of neonatal care practices during pregnancy, 53.8%, 23.8%, 41.9% and 43.0% had received TT, planed for birth and its complication, received ANC and received adequate information on neonatal care, respectively. Among the elements of neonatal care during labour and delivery, 17.5% and 95.0% used skilled care at birth and received social support, respectively.

Among the components after birth, 96.5% received immediate thermal care; 64.1% started breast-feeding within one hour of birth; 86.5% got clean cord care; 91.5% on exclusive breast-feeding; 56.5% got bathing at appropriate time (after 6 hours of birth) and 8.1% received vaccination (BCG and Polio-0) on the date of birth. By using these parameters, composite index was created by using PCA and mean score was determined. Accordingly, 59.5% (95%CI: 57.6%, 61.3%) of neonates scored above or equal to the mean score and labelled as good neonatal care (Table 12).

Table 12. Neonatal care practice in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3463).

Variables	*NO.*	*Unweighted %*	*Weighted %*
Received TT during pregnancy (at least 1 dose)	1962	56.7	53.8
Planed for birth and its complications	1202	34.7	23.8
Received skilled ANC Care at least once	1840	53.1	41.9
Adequate information on neonatal care	1501	43.3	43.0
Received skilled care at birth	1064	30.7	17.5
Social support during labour and delivery	3268	94.4	95.0
Appropriate immediate thermal care	3359	97.0	96.5
Clean cord care	3042	87.8	86.5
Timely initiation of breast feeding (within 1 hour)	2307	66.6	64.1
Exclusive breast feeding (within 28 days)	3176	91.7	91.5
Appropriate bathing time (>6hrs)	2160	62.4	56.5
Vaccines on date of birth (BCG and Polio 0)	425	12.3	8.1
Over all neonatal care practice			
Good Practice (≥Mean score)	2240	64.7	59.5
Poor Practice (<Mean score)	1223	35.3	40.5

4.5.2. Factors affecting neonatal care

To identify factors affecting neonatal care practice, mixed-effects multilevel linear regression model was used by taking neonatal care practice score as a continues outcome variable. To evaluate the existence of sufficient variation at the cluster level to apply the multilevel model, the ICC (ρ) was calculated in the empty model and it was found to be 0.332 (33.2%). The test of the preference of log likelihood versus linear regression was also strongly significant ($P < 0.0001$). Then, the final full model was run by including all the cluster level and individual level variables and the ICC (ρ) became 0.157. This again indicated that 15.7% of the variation was attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood versus linear regression was again strongly significant ($P < 0.0001$) (Table 7).

After adjusting in the final two-level mixed-effects linear regression model, factors affecting neonatal care practice existed both at the cluster level as well as at the individual level. Among the higher (cluster) level variables, place of residence was found to have statistically significant association with neonatal care practice. Being in urban residence was found to increase neonatal care practice significantly (β = 0.86; 95%CI: 0.45, 1.23).

Among the lower level variables, maternal education, husband‘s occupation, wealth quintiles, birth order and inter-birth interval had a significant association with neonatal care practice. Maternal education of primary (β =0.21; 95%CI: 0.10, 0.32) and secondary or above (β = 0.76; 95%CI: 0.55, 0.98) increased the neonatal care practice significantly as compared to illiterate mothers. Neonates, whose fathers were employed (β = 0.54; 95%CI: 0.30, 0.77) or merchants (β = 0.28; 95%CI: 0.09, 0.47) had received significantly higher neonatal care as compared to those whose fathers were farmers. Better wealth quintiles: second (β = 0.18; 95%CI: 0.03, 0.31), third (β = 0.30; 95%CI: 0.15, 0.46), fourth (β = 0.41; 95%CI: 0.25, 0.56) and fifth (β = 0.30; 95%CI: 0.14, 0.46) also increased neonatal care practice significantly. Similarly, inter-birth interval of 2-4 years (β = 0.20; 95%CI: 0.01, 0.39) and above 4 years (β = 0.34; 95%CI: 0.10, 0.58) significantly increased neonatal care practice. Birth order had inverse relationship with neonatal care. Birth order of 2^{nd}-4^{th} (β = -0.30; 95%CI: -0.52, -0.09) and above 4^{th} (β = -0.43; 95%CI: -0.68, -0.19) significantly reduced neonatal care as compared to first birth-order neonates (Table 13).

Table 13. Multilevel analysis of factors affecting neonatal care practice, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3463).

Variables	Crude estimate β (95%CI)	Adjusted estimate β (95%CI)
Level-2 (higher level)-communal variables		
Place of residence		
Urban	1.63 (1.51, 1.75)	0.86 (0.45, 1.23)
Distance from health centre (on foot)		
>2hours	-0.58 (-0.70, -0.45)	-0.09 (-0.45, 0.27)
Distance from Hospital (on foot)		
>2hours	-1.38 (-1.54, -1.23)	-0.33 (-0.77, 0.11)
Level-1-lower level (individual) variables		
Age (Years)		
20-29	-0.55 (-0.82, -0.2)	-0.21 (-0.44, 0.03)
>29	-0.88 (-1.14, -0.59)	-0.25 (-0.52, 0.11)
Educational status		
Primary education (1-8)	0.52 (0.41, 0.64)	0.21 (0.10, 0.32)
Secondary or above (≥9)	1.95 (1.75, 2.14)	0.76 (0.55, 0.98)
Occupation		
Employed	1.20 (0.94, 1.45)	0.18 (-0.06, 0.41)
Husband‘s occupation		
Employed	1.88 (1.71, 2,05)	0.54 (0.30, 0.77)
Merchant	1.28 (1.14, 1.42)	0.28 (0.09, 0.47)
Wealth index		
Second quintile	0.45 (0.27, 0.63)	0.18 (0.03, 0.31)
Third quintile	0.57 (0.38, 0.75)	0.30 (0.15, 0.46)
Fourth quintile	0.70 (0.52, 0.88)	0.41 (0.25, 0.56)
Fifth quintile	0.72 (0.54, 0.90)	0.30 (0.14, 0.46)
Birth order		
2^{nd} -4^{th}	-0.58 (-0.73, -0.44)	-0.30 (-0.52, -0.09)
≥5^{th}	-1.07 (-1.24, -0.91)	-0.43 (-0.68, -0.19)
Birth interval		
24-48 Months	0.34 (0.12, 0.56)	0.20 (0.01, 0.39)
>48 Months	0.93 (0.65, 1.21)	0.34 (0.10, 0.58)

4.5.3. Qualitative findings

The qualitative part was conducted for in-depth understanding of neonatal care practices and reasons in the community. Newborn feeding, thermal care, cord care and immunization were the focuses of the qualitative part.

Newborn feeding

According to the opinions of most of the respondents, previously there were problems in newborn feeding practices that most mothers do not start breast-feeding immediately. They also used to give fresh butter to the newborn to swallow with the assumption that he/she will not cry during the childhood. Now a days, the HEWs are educating the mothers and every mother gives breastfeeding immediately. No woman also gives additional feeding in the first month of life though some starts giving cow milk around 3-4 months.

Thermal care

Concerning thermal care, mixed practices were reported by majority of the respondents. As repeatedly mentioned, during home delivery, almost all newborns are wrapped with clean new towel and put in front of mothers or someone caries them carefully. However, almost all mothers and newborns are washed just immediately or within thirty minutes by cold water. This is because of lack of knowledge about the importance of delayed bathing.

A 28 years old FGD discussant said, *"I gave birth to my child two months back by the help of traditional birth attendant. Just immediately, as the placenta was out, she washed me and my newborn with cold water. As to me, this is what all women in our community practice...."*

A key informant TBA added, *"...Both the mother and the newborn are contaminated with dirty blood. How can they stay with it for long hours? That is why we encourage immediate wash of both the mother and the newborn...."*

Cord care

Majority of the respondents had the view that previously, the mothers reuse rather blades to cut umbilical cord and put butter on umbilical stamp. But now, every woman knows its drawback and no such practices.

Immunization

As reported by the majority, vaccination is the major problem of neonatal care. As most reported, previously mothers had no adequate knowledge and do not accept child immunizations. But now, every woman knows its benefits. However, the neonates are not getting appropriately because of many reasons from service providers. The major reported problems were unavailability of vaccines and when available, the providers do not open for few neonates.

A 24 years old FGD discussant stated, *"...I had taken my neonate two times to the health centre, but he never received the vaccine. On first day, the provider said, 'I can't open the vaccine for less than 10 children' and appointed me for a week. Again after a week, he said, 'no vaccine at all! Come another day!' I never went there again..."*

A HEW added, *"...we have been facing problems of open vial policy. We are not supposed to open BCG vial unless there are 10 neonates. We appoint mothers to bring on same day to open. But, they do not come on same day at same time. As a result, many neonates are not getting the BCG vaccine...."*

4.6. Neonatal mortality, causes and determinants (Paper-V)

4.6.1. Status of perinatal and neonatal mortality

From a total of 3463 live births, 110 died within 28 days of birth making neonatal mortality rate of 31.8 (95%CI: 26.4, 38.2) per 1000 live births (21 for urban and 35 for rural). In order to avoid urban over representation and under estimation of NMR, weighted analysis was done and it was found to be 35.5 (95%CI: 28.3, 42.6) per 1000 live births. In urban it was 20.0 (95%CI: 9.0, 31.0) as compared to 36.2 (95%CI: 28.7, 43.7) in rural. From these, 76 (69.1%) died within the first week of life making weighted early neonatal mortality rate to be 23.7 (95%CI: 18.5, 30.3). There were also 47 stillbirths making weighted stillbirth rate and perinatal mortality rate to be 16.5 (95%CI: 12.2, 22.4) and 39.8 (95%CI: 32.9, 48.1), respectively (Table 14).

Table 14. The status of perinatal and neonatal mortality in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n=3463).

Events	No.	Rate/1000 (95%CI) (unweighted)	Rate/1000 (95%CI) (weighted)
Total births	3510		
Total live-births	3463		
Stillbirths	47	13.4 (10.1, 17.8)	16.5 (12.2, 22.4)
Early neonatal mortality	76	22.0 (17.6, 27.4)	23.7 (18.5, 30.3)
Late neonatal mortality	34	9.8 (7.0, 13.7)	11.8 (8.2, 16.9)
Perinatal mortality	123	35.1 (29.5, 41.7)	39.8 (32.9, 48.1)
Neonatal mortality	110	31.8 (26.4, 38.2)	35.5 (28.3, 42.6)

4.6.2. Causes of neonatal mortality

Out of the total 110 neonatal deaths happened, verbal autopsies were conducted for 99 cases. Initially, the two interpreting physicians agreed on the most probable cause of death for 86 out of the 99 cases, which was 86.9%. For 6 (6.1%) of the cases, first and second most probable causes were exchanged between the physicians making the overall agreement rate of 93%. As a result, third physician interpreted the 13 cases and agreed with either of the physicians in 11 cases and the rest 2 cases were not agreed upon and classified as unspecified cause of death. With this, birth asphyxia (47.5%), neonatal infections (34.3%) and prematurity (11.1%) were the three leading causes of neonatal mortality (Figure 5).

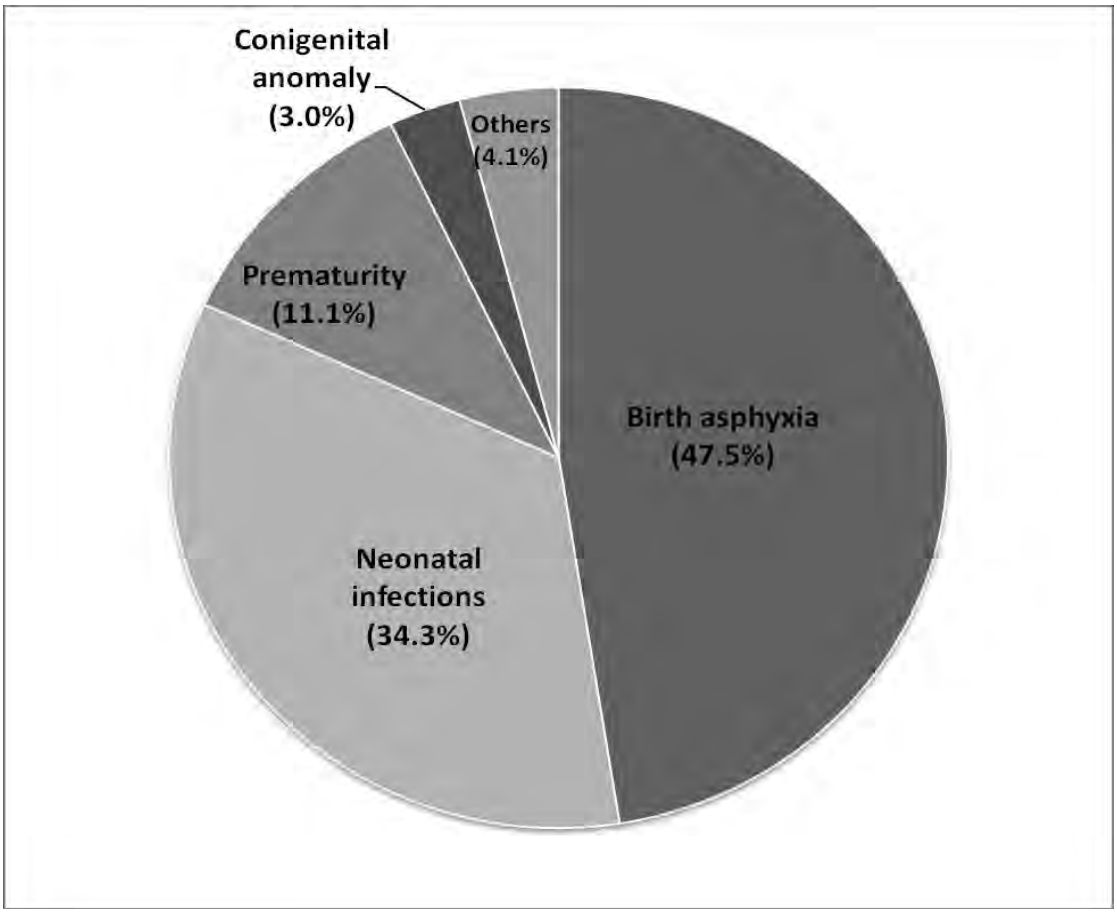

Figure 5. Causes of neonatal death, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013.

4.6.3. Determinants of neonatal mortality

To identify the determinants of neonatal mortality, mixed-effects multilevel logistic regression model was used. To evaluate the applicability of the model, the ICC (ρ) was calculated in the empty model and it was found to be 0.100 indicating that 10.0% of the variation was contributed by between cluster variation. The test of the preference of log likelihood Vs logistic regression was also strongly significant (P = 0.0003). Then, the full model was run by including all the cluster level and individual level variables and the ICC (ρ) was increased to 0.174 suggesting model improvement. This again indicated that 17.4% of the variation was attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood versus logistic regression was again strongly significant (P = 0.0001) (Table 7).

After adjusting in the final two-level mixed-effects logistic regression model, cluster level variables were less important in predicting neonatal mortality and all had non- significant associations. Among the lower level variables, maternal socio demography and wealth quintiles also had non-significant associations. Whereas, maternal health care during pregnancy and delivery, delivery conditions, neonatal conditions and neonatal care practice were identified as important determinants of neonatal mortality.

First birth order (OR = 5.45; 95%CI: 1.81, 16.40) and birth order of 5^{th} or above neonates (OR = 2.61; 95% CI: 1.43, 4.74) were more likely to die during neonatal period as compared to 2^{nd} - 4^{th} order. Those whose mothers had 1-3 ANC visits (OR = 0.51; 95% CI: 0.28, 0.93) and 4 or more visits (OR = 0.35; 95% CI: 0.18, 0.68) were less likely to die during neonatal period as compared to those who had no ANC visit at all. Neonates born at health centres were 43% (OR = 0.43; 95% CI: 0.17, 0.99) less likely to die during neonatal period as compared to those who were born at home. However, hospital delivery (OR = 0.73; 95% CI: 0.31, 1.70) and skilled attendants (OR = 0.57; 95% CI: 0.28, 1.16) had non-significant association as compared to home delivery and non- skilled attendants, respectively.

Premature births (GA at birth <37weeks) were also found to increase the likelihood of neonatal death as compared to term births (OR = 2.09; 95% CI: 1.03, 4.22). Premature and prolonged rupture of membrane before the onset of labour had increased the likelihood of neonatal death. Rupture of membrane 1-12 hours (OR = 2.71; 95% CI: 1.13, 6.53) and >12 hours (OR = 7.74; 95% CI: 2.27, 26.38) before the onset of labour had significantly higher risk of neonatal death as compared to rupture of membrane after the onset of labour.

The occurrence of obstetric complications during labour (OR = 6.77; 95% CI: 3.82, 12.00) and twin births (OR = 8.21; 95% CI: 3.46, 19.47) were among the strong predictors of neonatal mortality. Similarly, small size (OR = 1.95; 95%CI: 1.11, 3.42) and big size (OR = 10.73; 95% CI: 5.65, 20.37) at birth were found to increase the likelihood of neonatal death as compared to average size neonates. Not having good comprehensive neonatal care practice was also the other strong predictor of neonatal mortality (OR = 10.36; 95%CI: 5.13, 20.94) (Table 15).

Table 15. Multilevel analysis of determinants of neonatal mortality, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013.

Variables	Neonatal Mortality			Crude OR(95%CI)	Adjusted OR(95%CI)
	Died (n=110 n (%)	Survived (n=3353) n (%)	Total (n=3463) n (%)		
Higher level variables					
Residence					
Urban	18 (2.1)	843 (97.7)	861 (100.0)	1.00	1.00
Rural	92 (3.5)	2510 (96.5)	2602 (100.0)	1.72 (1.03, 2.86)	1.08 (0.33, 3.57)
Average distance from Health centre (on foot)					
≤2 hours	77 (3.1)	2417 (96.9)	2494 (100.0)	1.00	1.00
>2hours	33 (3.4)	936 (96.6)	969 (100.0)	1.12 (0.73,1.68)	1.06 (0.49, 2.32)
Average distance from Hospital (on foot)					
≤2 hours	10 (1.9)	519 (98.1)	529 (100.0)	1.00	1.00
>2hours	100 (3.4)	2834 (96.6)	2934 (100.0)	1.83 (0.95, 3.53)	1.92 (0.34, 4.20)
Level-1 variables					
Age of mother					
15-19	3 (1.7)	171 (98.3)	174 (100.0)		1.00
20-29	64 (2.9)	2145 (97.1)	2209 (100.0)	1.70 (0.53, 5.47)	3.39 (0.81, 14.21)
>29	43 (4.0)	1037 (96.0)	1080 (100.0)	2.36 (0.73, 7.70)	4.04 (0.87, 18.71)
Educational status					
Illiterate	69 (3.7)	1802 (96.3)	1871 (100.0)	1.00	1.00
Primary (1-8)	37 (2.9)	1233 (97.1)	1270 (100.0)	0.78 (0.52, 1.18)	0.96 (0.56, 1.66)
Secondary or above (≥9)	4 (1.2)	318 (98.8)	322 (100.0)	0.33 (0.12, 0.91)	0.52 (0.13, 2.13)
Mother's occupation					
Unemployed	107 (3.3)	3173 (96.7)	3280 (100.0)	1.00	1.00
Employed	3 (1.6)	180 (98.4)	183 (100.0)	0.50 (0.16, 1.58)	0.41 (0.10, 1.81)
Father's occupation					
Farmer	86 (3.5)	2372 (96.5)	2458 (100.0)	1.00	1.00
Employed	6 (1.6)	370 (98.4)	376 (100.0)	0.45 (0.19, 1.03)	1.32 (0.36, 4.84)
Merchant	18 (2.9)	611 (97.1)	629 (100.0)	0.81 (0.49, 1.36)	1.92 (0.79, 4.66)
Wealth quintiles					
First quintile	30 (4.4)	648 (95.6)	678 (100.0)	1.00	1.00
Second quintile	24 (3.4)	679 (96.6)	703 (100.0)	0.76 (0.44, 1.32)	0.87 (0.43, 1.74)
Third quintile	24 (3.5)	665 (96.5)	689 (100.0)	0.78 (0.45, 1.35)	1.02 (0.51, 2.04)
Fourth quintile	17 (2.4)	680 (97.6)	697 (100.0)	0.54 (0.30, 0.99)	1.01 (0.47, 2.15)
Fifth quintile	15 (2.2)	681 (97.8)	696 (100.0)	0.48 (0.25, 0.89)	0.72 (0.32, 1.62)
Birth order					
1st	28 (3.8)	703 (96.2)	731 (100.0)	2.00 (1.20, 3.28)	5.45 (1.81, 16.40)
2nd -4th	36 (2.0)	1793 (98.0)	1829 (100.0)	1.00	1.00
5th or above	46 (5.1)	857 (94.9)	903 (100.0)	2.67 (1.72, 4.17)	2.61(1.43, 4.74)
Preceding birth interval					
<24 months	8 (3.1)	247 (96.9)	255 (100.0)	1.00	1.00
24-48 months	62 (2.9)	2095 (97.1)	2157 (100.0)	0.91 (0.43, 1.93)	1.34 (0.49, 3.65)
>48 months	12 (3.8)	308 (96.2)	320 (100.0)	1.20 (0.48, 2.99)	2.23 (0.66, 7.57)
Nuliparous	28 (3.8)	703 (96.2)	731 (100.0)	NA	NA

NA = Not Applicable

Table 15. Multilevel analysis of determinants of neonatal mortality... (continued)

Variables	Neonatal Mortality			Crude OR (95%CI)	Adjusted OR (95%CI)
	Died (n=110) n (%)	Survived (n=3353) n (%)	Total (n=3463) n (%)		
Birth preparedness plan					
Prepared	28 (2.3)	1174 (97.7)	1202 (100.0)	1.00	1.00
Not prepared	82 (3.6)	2179 (96.8)	2261 (100.0)	1.58 (1.02, 2.44)	1.00 (0.55, 1.84)
Frequency of ANC					
No visit at all (0)	32 (3.9)	787 (96.1)	819 (100.0)	1.00	1.00
1-3 visits	44 (3.1)	1362 (96.9)	1406 (100.0)	0.80 (0.50, 1.26)	0.51 (0.28, 0.93)
≥4 visits	34 (2.7)	1204 (97.3)	1239 (100.0)	0.70 (0.43, 1.14)	0.35 (0.18, 0.68)
Place of delivery					
Home	83 (3.5)	2316 (96.5)	2399 (100.0)	1.00	1.00
Hospital	17 (3.9)	418 (96.1)	435 (100.0)	1.14 (0.67, 1.93)	0.73 (0.31, 1.70)
Health centre	10 (1.6)	619 (98.4)	629 (100.0)	0.45 (0.23, 0.87)	0.43 (0.17, 0.99)
Attendant of delivery					
Non-skilled	83 (3.5)	2316 (96.5)	2399 (100.0)	1.00	1.00
Skilled	27 (2.5)	1037 (97.5)	1064 (100.0)	0.73 (0.47, 1.13)	0.57 (0.28, 1.16)
Gestational age at birth					
Term (≥37 weeks)	90 (2.9)	3030 (97.1)	3120 (100.0)	1.00	1.00
Preterm (<37 weeks)	20 (5.8)	323 (94.2)	343 (100.0)	1.09 (1.27,3.43)	2.09 (1.03, 4.22)
Premature rupture of membrane					
No (during labour)	84 (2.9)	2773 (97.1)	2857 (100.0)	1.00	1.00
<1 hour before labour	7 (1.5)	470 (98.5)	477 (100.0)	0.49 (0.23, 1.07)	0.40 (0.16, 1.01)
1-12 hours before labour	12 (12.4)	85 (87.6)	97 (100.0)	4.66 (2.45, 8.86)	2.71 (1.13, 6.53)
>12 hours before labour	7 (21.9)	25 (78.1)	32 (100.0)	9.24 (3.89, 21.97)	7.74 (2.27, 26.38)
Duration of labour					
<6hours	36 (1.8)	1931 (98.2)	1967 (100.0)	1.00	1.00
6-12 hours	45 (4.8)	885 (95.2)	930 (100.0)	2.73 (1.75, 4.26)	1.47 (0.83, 2.58)
>12 hours	29 (5.1)	537 (94.9)	566 (100.0)	2.90 (1.76, 4.78)	0.84 (0.41, 1.72)
Complication during labor					
No	40 (1.5)	2645 (98.5)	2685 (100.0)	1.00	1.00
Yes	70 (9.0)	708 (91.0)	778 (100.0)	6.54(4.40, 9.73)	6.77 (3.82, 12.00)
Types of birth					
Singleton	94 (2.8)	3293 (97.2)	3387 (100.0)	1.00	1.00
Twins	16 (21.1)	60 (78.9)	76 (100.0)	9.34 (5.19, 16.83)	8.21 (3.46, 19.47)
Sex of neonate					
Male	69 (3.9)	1710 (96.1)	1779 (100.0)	1.00	1.00
Female	41 (2.4)	1643 (97.6)	1684 (100.0)	0.62 (0.42, 0.92)	0.77 (0.48, 1.24)
Size of neonate at birth					
Small	41 (5.3)	736 (94.7)	777 (100.0)	3.37 (2.16, 5.25)	1.95 (1.11, 3.42)
Average	40 (1.6)	2419 (98.4)	2459 (100.0)	1.00	1.00
Big	29 (12.8)	198 (87.2)	227 (100.0)	8.86 (5.38, 14.60)	10.73 (5.65, 20.37)
Neonatal care practice					
Good	19 (1.0)	1806 (99.0)	1825 (100.0)	1.00	1.00
Poor	91 (5.6)	1547 (94.4)	1638 (100.0)	5.59 (3.39, 9.17)	10.36 (5.13, 20.94)

Table 16. Summary of the main findings of the dissertation according to the objectives, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013.

Paper	Objective/problem addressed	Main findings
I	Pooled effect of health facility delivery on neonatal mortality	RR = 0.71 (95% CI: 0.54, 0.87) Health facility delivery reduced neonatal mortality by 29%
II	The status of birth preparedness and complication readiness (BP and CR)	23.3% (95% CI: 21.8%, 24.9%)
	Factors affecting birth preparedness and complication readiness	Place of residence, access to BEmOC, educational status, husband‘s occupation, wealth quintiles, knowledge of key danger signs during delivery, attitude towards BP & CR and ANC use
III	The status of skilled care use during delivery	17.5% (95% CI: 16.2%, 18.8%)
	Relation between intention and action in skilled care use	Significant effect (OR=1.20; 95% CI: 1.04, 1.38)
	Factors affecting skilled care use	Place of residence, access to BEmOC, educational status, husband‘s occupation, wealth quintiles, gravida, inter-pregnancy interval, knowledge of key danger signs during labour and delivery, ANC use and BP & CR plan
IV	The status of neonatal care	59.5% (95% CI: 57.6%, 61.3%)
	Factors affecting neonatal care	Place of residence, educational status, husband‘s occupation, wealth quintiles, birth order and preceding birth interval
V	The status of perinatal and neonatal mortality	Early neonatal mortality = 23.7 per 1000 LBs (95%CI: 18.5, 30.3) Late neonatal mortality = 11.8 per 1000 LBs (95%CI: 8.2, 16.9) Perinatal mortality = 39.8 per 1000 deliveries (95%CI: 32.9, 48.1) Neonatal mortality = 35.5 per 1000 LBs (95%CI: 28.3, 42.6)
	Causes of neonatal mortality	Birth asphyxia (47.5%), neonatal infections (34.3%), prematurity (11.1%), congenital anomalies (3.0%) and others (4.1%)
	Determinants of neonatal mortality	Birth order, preceding birth interval, ANC use, place of delivery, gestational age at birth, premature rapture of membrane, complication during labour, twin birth, size of neonate at birth and neonatal care practice

5. DISCUSSIONS

This study tried to assess the status of birth preparedness and complication readiness and associated factors, the status and determinants of skilled care use, the status and factors affecting neonatal care and the status, causes and determinants of neonatal mortality.

5.1. Birth preparedness and complication readiness and affecting factors

As the occurrences of complications during the process of childbirth are unpredictable, every woman needs to be aware of the key danger signs of obstetric complications during pregnancy, delivery and the postpartum period. This knowledge will ultimately empower them and their families to make prompt decisions to seek care from skilled birth attendants (11). However, the knowledge of key danger signs in this study was found to be very low as less than one in twenty women were able to mention all the key danger signs occurring during pregnancy, during delivery and after birth.

Similar problems were reported in other prior studies in Ethiopia and other African countries (30, 31, 66, 67). This low level of knowledge of key obstetric danger signs in developing countries may be explained by the low coverage of ANC visits and inadequate number of visits. This may also indicate that less attention might have been given to key danger signs while giving health education and advice during ANC.

In this study, about seven in ten of the respondents planned to save money and more than five in ten planned to arrange transport, which were relatively better. However, less than one in five women planned to arrange blood donor and to use skilled care during delivery. Similar low level of preparation has also been reported in other prior studies in the country (30, 68). This may be explained by the low socio-economic status, low level of knowledge and low education among women as well as the general population. As birth preparedness and complication readiness is relatively a recent strategy, service providers and program planers might not have given special attention.

The findings of this study, particularly the preparation for skilled care use, were lower than some other countries‘ study like Tanzania (67), Nigeria (69) and Burkina Faso (70). This difference may be explained by the difference in socio-economic status, as these countries are relatively at a better wealth status than Ethiopia, availability and accessibility of services or any other interventions in the countries. The overall status of birth preparedness and complication readiness in this study was 23.3%. It is consistent with other prior studies conducted more than

five years back in the country (30, 31). This suggests that in spite of many efforts by the government, the progress is very slow.

In this study, the adjusted final multilevel model found that factors affecting BP and CR existed both at the community (cluster) level and at the individual level. It also pointed out that though both the community level and individual level factors are important for program implications, the community level factors (place of residence and access to BEmOC) are relatively resistant to change. Therefore, more emphasis needs to be given to the individual and household level factors, which are more feasible to be intervened and more prone to change.

Among the cluster level factors, being in urban residence was found to increase the likelihood of preparation for birth and its complication by about six times in this study. Having health centres within 2 hours distance on foot on the average was also found to increase the likelihood of preparation by about three times. These findings are in line with previous studies (30, 67). This may be explained by the fact that women in urban areas have access to health information through different media and relatively have low barriers due to distance and lack of transportations as compared to the rural women. Similarly, having nearby health facility increases access to health information and reduces distance barriers leading to better preparation.

Among socio-demographic and economic related factors, education, husband‘s occupation and wealth quintiles were identified as determinants of BP and CR in this study. This is again in line with the findings of other studies conducted in Ethiopia as well as other countries (30, 67, 69, 70). The reasons may be, having high education, being employed and merchant are directly related to access to information, better knowledge and income, which enable them to be prepared for birth and its complications.

Most importantly, Knowledge of key danger signs during labour and delivery, women‘s attitude towards BP and CR and ANC visits were found to be the determinant factors of BP and CR in this. Similar findings has also been reported in prior studies in Ethiopia and others (30,31,67). This may be due to the advice about the risks of pregnancy and importance of BP and CR given during ANC. The health education during ANC also increases knowledge of key danger signs and develops favourable attitude that enhance preparation for birth and its complications.

5.2. The status and determinants of skilled care use

The World Health Organization strongly recommends that every pregnancy should be delivered under skilled care (71). The United Nation‘s MDG also had set a target of 90% coverage of skilled care by the end of 2015. Nevertheless, in this study, the status of skilled care use was found to be very low (17.5%) as compared to this target. This is almost comparable with the findings of other previous studies in the country in which the coverage of skilled care uses were less than 15% (30, 72-76). However, this finding is lower than the findings of similar studies conducted in other developing African countries in which skilled care use ranged from 40-50% (77-79). The difference may be due to variations in education, socio-economy, access to skilled care or any other interventions. This indicates that a lot needs to be done in the study area as well as in the country to increase the status of skilled care use to attain the desired target.

Though intention did not 100% imply action in skilled care use, delivery planning by identifying place of delivery significantly increased the actual use in this study. The major reason for those who did not actually translate their intention in to action was that complication during labour was not predictable. This finding is consistent with other prior studies in which occurrence of problem during labour is the primary reason for women in developing countries to seek skilled care at birth (75, 76).

In this study, both the higher level and lower level variables were found to be important determinants of skilled care use suggesting the importance of interventions both at the community as well as individual levels. Among the higher level variables, place of residence and access to BEmOC were the important determinants of skilled care use. This is consistent with other studies conducted before (72-76). This may be explained by the fact that women in urban areas have more access to skilled care, access to education and media that might have increased their level of risk perception and thereby increased skilled care use.

Among the individual level variables, maternal education, husband‘s occupation and wealth quintiles were identified as determinants of skilled care use in this study. These findings are again consistent with other prior studies in the country as well as aboard (72-80). This may be due to the reason that better education increases access to information, risk perception, employment and income, which in turn increase health-seeking behaviour for obstetric complications.

Among the obstetric factors, number of pregnancies and inter-birth interval were found to be determinants of skilled care use in this study. Number of pregnancies had inverse relationship with the rate of skilled care use. Multi-gravida women were less likely to use skilled care compared to primis. This is consistent with other studies conducted before (72-75). This may be due to the existence of less risk and less occurrence of prolonged labour among multigravida mothers as compared to primi-gravida mothers.

On the other hand, inter-birth interval of more than 4 years had significant effect in increasing skilled care use. Many international evidences have also suggested that inter-birth interval of 2 years and above significantly improves maternal and child health, including skilled care use (81). This may be due to the reason that mothers may get free time and rest to prepare themselves when they have enough time between pregnancies and utilize the services.

Knowledge of key danger signs during labour, ANC visit and BP and CR plan were also among the individual level variables having significant effect on skilled care use in this study. This is also similar with the findings of other previous studies (72-77, 82, 83). This can be explained by the reason that the women might have received advice on the importance of skilled care during ANC visits that facilitated the actual practice at the time of labour.

5.3. The status of neonatal care and affecting factors

The overall status of neonatal care practice in this study was 59.5%, which is relatively higher than the previous study done in Addis Ababa (29%) (34). However, majority of the components of the neonatal care practice along the continuum of care are still low. For example, all the four components of neonatal care during pregnancy (receiving TT, planning for birth, attending ANC and receiving adequate information) were less than 50%. Similarly, the coverage of skilled care use was low (17.5%). These findings are almost comparable with the national figures reported in EDHS 2011 (8) suggesting the need for particular interventions. This low coverage may be explained by low awareness of mothers about neonatal problems and the importance of neonatal care that might have lead to low utilization of the cares.

Care of umbilical cord always needs special attention as it can function as the entry point for infections. World Health Organization recommends dry cord care, where nothing is placed on cord stump unless indicated. Various studies done in developing countries have reported that mothers apply various substances to the umbilical cord stump [23-27]. In the contrary, clean cord care practice was found to be better (86.5%) in this study. This may be due to difference in cultural practices in relation to neonatal care. In addition, the current community based interventions by health extension workers might have contributed to the reduction of traditional cord care practices in the study area.

The WHO recommends early initiation of breast milk (within one hour of birth) and avoiding extra feeding up to 6 months of age. In this study, 64.1% of the newborn started breast milk within one hour of birth and 91.5% was on exclusive breast milk during the first 28 days of birth. This is consistent with the finding of the study conducted in Addis Ababa in which 61.4% of newborns started breast milk within the first hour of birth (34). Similar findings were also reported in studies done in Nigeria (65.3%) (32) and in Philippines (68.2%) (33). This may indicate knowledge gap on the importance of colostrum for the neonatal health in developing countries.

In this study, place of residence was one of the predictors of neonatal care practice. Neonatal care practice was higher among mothers from urban residence as compared to the rural mothers. This is consistent with other prior studies (32, 34). This may be explained by the

reason that women in urban areas have access to information and media and more likely to use ANC and skilled care at birth that might have contributed to this difference.

Neonatal care practice was found to increase significantly as educational status and wealth quintiles increase. Similarly, having employed husband increased neonatal care practice. These findings are inline with other prior studies (32-34). This may be explained by the reasons that when education increases, knowledge about health care, access to employment and income increase. When there is high income or better wealth status, mothers are more likely to seek services both for themselves and for their neonates.

In this study, first-birth-order neonates received significantly higher care as compared to higher-birth-order neonates. This may be due to the reason that families give special care for first child and this goes down as the number of live children increases because of negligence and economic issues to give care for all children. Inter-birth interval was another predictor of neonatal care practice. Birth-interval of two years or above significantly increased neonatal care. This finding is similar with other studies conducted before (32, 34). The reason could be, when mothers get closely spaced births, they are expected to care for both children and themselves, which may lead to maternal exhaustion and negligence. As a result, the care for the later one decreases.

5.4. The status, causes and determinants of neonatal mortality

The neonatal mortality rate in this study is 35.5 (95%CI: 28.3, 42.6) per 1000 live births, which is still high. This is similar with the finding of EDHS 2011, 37.0 per (95%CI: 33.7, 40.3) 1000 live births (8). However, this is higher than the findings of studies done in other countries with high neonatal mortality like India (19.5 per 1000 live births) (84) and Indonesia (23.8 per 1000 live births) (85). This indicates that the situation of neonatal mortality remains high and non-progressing suggesting targeted interventions by all partners at different levels.

In this study, 57.3% and 69.1% of neonatal deaths occurred on the date of birth and in the 1st week of life, respectively. These findings are similar with other prior studies in which more than three-quarter of neonatal deaths occurred in the first week of life (41, 85-88). The reason could be majority of neonatal mortality in developing countries are related to

conditions of labour, intra-partum and the immediate newborn care practices. Moreover, the major causes of death are birth asphyxia, early neonatal infections and prematurity. These suggest that neonatal survival interventions have to target the intra-partum as well as immediate and early neonatal periods.

In this study, higher-level factors were found to be less important in determining neonatal mortality. Similarly, lower level factors related to basic socio-demography and wealth quintiles were less important. Instead, lower level factors related to maternal and neonatal complications and care before, during and after delivery were the most important determinants of neonatal mortality. This finding is consistent with some other prior studies in which higher-level variables had less importance in determining neonatal mortality (86, 88-90). However, this finding is in contrast to the findings of study done in rural India in which both the higher and lower level factors were equally important (84). This indicates that the higher-level factors that are less amenable to short term interventions have to be considered as distant factors and special focus needs to be given to the immediate proximal factors of neonatal mortality, which are more feasible to be intervened.

First birth order and birth order of five or above were found to increase the likelihood of neonatal mortality by more than five and two times, respectively. This may be due to high risk of occurrence of complications during delivery among nuliparous and grand-multiparous mothers. In this study, having ANC visit and giving birth at health centre decreased neonatal mortality significantly. This is consistent with previous studies conducted in Ethiopia and other countries (85, 91). This may be because, necessary health conditions of mothers can be screened and treated earlier during ANC visits. Moreover, health facility delivery is very necessary in detecting complications earlier and providing clean and safe delivery. However, this is be practical if women come to appropriate health facility at early stage of labour.

In the contrary, delivery at hospital and skilled attendants at birth had non-significant association with neonatal mortality in this study. Similarly, in the systematic review and meta-analysis we conducted before this study, in 9 of the 19 studies included, health facility delivery had non-significant effect on neonatal mortality (62). Similar findings have been reported in some other studies in the country and abroad (87, 92). These may be because,

majority of hospital deliveries in developing countries, including Ethiopia, are as a result of self referral after all attempts failed (87). In this study for example, 43.5% of hospital deliveries were because of occurrence of problems during labour. The qualitative part of this study also clearly reflected that women do not go to hospital for delivery unless life threatening complication is occurred. This highlighted the importance of addressing the first and the second delays. This means, giving birth at hospital attended by skilled attendant may not be a guarantee to avert neonatal mortality unless the woman comes to the right health facility at the right time. Inadequacy of the sample size as, the number of hospital deliveries were low, and quality of care at facility could be the other possible explanations.

Intra-partum conditions, neonatal conditions and immediate neonatal care practices, including prematurity, occurrence of maternal complications during labour, PROM, twin birth, size of neonate at birth and comprehensive neonatal care practice were identified as determinants of neonatal mortality in this study. These findings are consistent with other previous studies conducted in the country and abroad in which the intra-partum and neonatal conditions were found to be the important predictors of neonatal mortality (41, 86, 87, 89, 90, 92).

This may be explained by the fact that premature and twin births are more likely to be under-weight and more prone to complications and infections. Similarly, long staying PROM and intra-partum complications increase the risk of infections and birth asphyxia. In line with this, the verbal autopsy identified birth asphyxia, neonatal infections and prematurity as the major causes of neonatal mortality accounting for 93%. This is also in line with other prior studies, where the three causes accounted for more than four-fifth of neonatal mortality (86, 93-95).

While infection is the leading cause of neonatal mortality in many studies in developing countries (23, 86, 93), birth asphyxia was the leading cause of death (47.5%) in this study. The high proportion of home deliveries in the absence of skilled attendants may explain this finding. Knowledge and skill deficiencies in prevention, diagnosis and management by unskilled attendants might have contributed to perinatal complications associated with neonatal asphyxia in these communities. The association between elevated neonatal mortality and home deliveries by unskilled attendants highlights the importance of delivery care education to local service providers.

6. VALIDITY, GENERALIZABILITY AND IMPLICATIONS

6.1. Validity and generalizability

Making possible efforts to increase the internal and external validity of the findings is a mandatory procedure in any study. In this regard, this dissertation tried to utilize possible options to increase both the internal and external validity at all stages, including during design, data collection processes and data analysis.

Internal validity

According to Rothman, internal validity refers to absence of systematic error that causes the study findings to differ from the true values as defined in the study objectives. While the results of a study may reflect the true effect of an exposure on the development of the outcome under investigation, it should always be considered that the findings may in fact be due to an alternative explanation. Such alternative explanations may be due to the effects of chance (random error), bias or confounding, which may produce spurious results, leading to the conclusion of the existence of a valid statistical association when one does not exist, or alternatively, the absence of an association when one is truly present. Observational studies are particularly susceptible to the effects of chance, bias and confounding and need to be considered at both the design and analysis stage of a study so that their effects can be minimized (96). Thus, as an observational study, this dissertation tried to consider the role of chance, bias and confounding at all stages.

Chance (random error):

The presence of chance (random variation) must always be kept in mind in designing any studies and in interpreting the data. Because, small sample size may lead to imprecise estimates. The role of chance in this dissertation was addressed by using adequate and representative sample size (3612 mothers coming from 73 clusters), which were estimated based on necessary assumptions including power. To ensure representation, urban-rural stratification and proportional allocation to sizes were also done. In addition, the largest sample size was used for all the objectives to increase precision and power. Necessary statistical tests were also done to quantify the role of chance by determining *P-values* and the 95%CI for each measure of association (odds ratio). The narrower the CI, the higher the precession and the lower the random errors.

Bias

Bias is any systematic error in a study that may result in incorrect estimate of the association between exposure and outcome of interest. So, careful consideration and control of the ways in which a bias may be introduced during the design and conduct of the study is essential in

order to limit the effects on the validity of the study results. It may arise as a result of selection bias or information bias (96).

Selection bias occurs when the two groups being compared differ systematically and the differences in the characteristics are related to either the exposure or outcome. As this dissertation is primarily based on observational cohort study, selection bias has minimal effect. Because, the respondents were identified from 73 clusters selected randomly and all eligible pregnant women in the selected clusters were enrolled to the study. In cohort studies, selection bias may also happen due to losses to follow up. In this study, most of the exposures are service use and the primary outcome is neonatal mortality. But, all the loss to follow up cases were happened during pregnancy randomly (not different from the others at the baseline), and not related to either the exposures of interest or the outcome. So, it has limited effect on the findings of the study. All missing data were also carefully assessed during analysis that they were random and not related to exposure or outcome of interest.

Information bias results from systematic differences in the way data on exposure or outcome are obtained from the various study groups. This may result because of differences in data collectors (observers), variation in underlying characteristics, misunderstanding of the questions during interview either by the data collector or the respondent, unwilling to respond or forgetting (recall) by respondent, incomplete or inaccurate recording. In order to reduce the bias due to data collectors, similar data collectors, females who completed 10^{th} grade, familiar with the local languages and culture were used at the baseline as well as at the last phase. The instruments were also adapted from standard questionnaires validated in other developing countries and pre-tested before actual data collection. Intensive training and supervision were also done for better understanding of the instruments and accurate recording. Incomplete and inconsistent questionnaires were also recompleted. Local languages were used to reduce misunderstanding by the respondents. As this is prospective cohort, recall bias is less likely.

Confounding

Confounding involves the possibility that an observed association is due, totally or in part, to the effects of differences between the study groups (other than the exposure under investigation) that could affect their risk of developing the outcome being studied. Confounding factors, if not controlled for, cause bias in the estimate of the impact of the

exposure being studied. Confounding can be addressed by restriction, stratifying, mating or multivariate analysis (96).

To address confounding, this dissertation tried to identify as much factors as possible from the existing literatures and developed conceptual framework during designing stage. Multivariate analyses were also done to control for the possible confounding factors identified during the literature review. The multivariate analysis also utilized advanced models (multilevel) to look at the factors at different levels. Interactions and other conditions that can possibly affect the associations were also addressed in the multilevel models.

To assess the quality (validity) of qualitative study, Lincolin and Guba identified four parameters: credibility, dependability and conformability for the internal validity and transferability for the external validity (97). To ensure credibility of the qualitative findings in this dissertation, experts who had stayed long in the study area and well familiar with the local culture collected the data (in-depth interviews and FGDs). Diverse categories of respondents (mothers, husbands, traditional birth attendants, health extension workers and service providers) were also involved to have different opinions, arguments and as much genuine information as possible. Finally, the findings were triangulated with the quantitative one. Dependability refers whether the findings of this study may be repeated in other places by other researcher. So, the interview guides and discussion guides are annexed for others to do consistently. Conformability is the ability that these findings can be confirmed by others. In addition to the final report, all the audio-recorded and transcribed data were confidentially kept to be availed based on request.

External validity (generalizability)

External validity is the extent to which the results of a study can be generalized to other situations and to other people at other places and at other times. It can be affected by the geographic area involved, the background of the participants included, the representation of different socio-cultural and ecological characteristics (96). This dissertation used representative sample size (3612 women) randomly selected from 73 clusters (*kebeles*) in five rural districts and two town administrations. Besides, urban rural stratification and proportional allocations were done. The instruments were also pretested for cultural suitability and acceptance. The nature of maternal health care use, neonatal care practices, determinants and causes of neonatal mortality are context specific. Therefore, the findings of

this study may be generalized to some parts of Oromia region having similar characteristics in population, culture, access to health care and health care seeking behaviours. However, the external generalizability to other parts of the country or countries out of Ethiopia may depend on the similarities of the existing socio- cultural, socio-economic and maternal and child health care related factors. Transferability is the term used to refer to the external validity in qualitative studies, which will depend on the similarities of the cultural context of the study area and population.

6.2. Policy and program implications of the study

For policy and program implications, this study came up with the evidence that birth preparedness and complication readiness plan has an effect on skilled care use. However, intention does not always (100%) imply action as complication during labour is unpredictable. This pointed out to the importance of raising the knowledge of women on key danger signs, risk perception and enhancing birth planning by every pregnant woman and her family so that delays to health care use can be minimized.

Hospital delivery and skilled care at birth had statistically non-significant association. However, this does not mean that they are programmatically non-significant. Rather, they pointed to the importance of addressing delays so that women go to the right health facility at the right time so as to save the lives of the neonates.

This study also came up with the evidence that both community level and individual level factors have a contribution in maternal and neonatal health outcomes. However, the community level factors have direct effect on birth preparedness and complication readiness, skilled care use and neonatal care practice, which in turn determine the neonatal mortality and have no direct effect on neonatal mortality. Instead, the individual level factors like intra-partum conditions and the immediate neonatal period have a direct effect on neonatal mortality.

Therefore, interventions need to target community level factors to improve birth planning, skilled care use and neonatal care practices and target the individual level factors to improve neonatal survival. Moreover, targeting the three major causes of neonatal death (birth asphyxia, neonatal infections and prematurity) can avert more than nine in ten of neonatal deaths.

7. STRENGTHS AND LIMITATIONS OF THE STUDY

7.1. Strengths of the study

This study has its own strengths in that the design was prospective follow up study that helped to measure the true stats maternal and neonatal care practice and the status of neonatal mortality, which is the major limitation of secondary data and cross-sectional studies. Besides, as it was a community-based prospective follow-up study, it tried to pick-up all neonatal deaths happened both at health facilities as well as at home and measured the fresh memory of the mothers concerning service use and neonatal mortality and minimized recall bias. It also used large sample size that resulted in high power and precision for the multilevel analyses.

In addition, strong statistical models (mixed-effects multilevel analyses) were used to handle clustering effects and identify factors at different levels for intervention purposes. The study also used mixed methods that helped to come up with comprehensive findings for policy and program implications. Standard and validated epidemiological tools were also adapted to increase the reliability and validity of the data.

7.2. Limitations of the study

- This study may have its own limitations in that some medical terms were difficult to translate exactly to local languages, which might have affected the respondents' understanding. To reduce this limitation, local language experts translated the instruments. In addition, local data collectors, who were fluent in local languages and familiar with local terms, collected the data.

- Some variables like wealth quintiles, attitude and neonatal care practice were subjective. In addition, they were determined by PCA that excludes some variables from the analysis. Dichotomizing or categorizing such composite variables at some cut-off points may have their own limitations in speaking about level of coverage. Possible efforts were made to use standard and as many variables as possible to make them more objective.

- This study measured access to health facility, but did not address the quality of the health facility, which could have been one of the determinant factors and may be area for further

research. In addition, access to CEmOC had non-significant effect on skilled care use. This might be because, the distance was measured in women‘s oral approximate report and no instruments like GPS were used to know the exact distance. There might also be some unobserved cluster (community) level factors like road and transport availability that might have affected this relation, which needs to be considered in future researches.

- The verbal autopsy was based on mothers‘ report of signs and symptoms concerning the underlying causes of neonatal death. This may not be as specific as the clinical diagnosis in identifying the exact cause of death. To address this, standardized and validated questionnaire was adapted and experienced data collectors and interpreters were used.

8. CONCLUSIONS

This study found that the status of birth preparedness and complication readiness as well as skilled care use are low in the study area. Though the status of neonatal care practice is relatively better, the status of neonatal mortality is still very high and has no sign of decline as compared to the national figure as well as the MDG target. Birth preparedness and complication readiness has a significant effect on improving skilled care use at birth, but has non-significant effect on neonatal mortality. Instead, provision of the minimum neonatal care package has a great potential in reducing neonatal mortality.

The higher (community) level factors such as place of residence and access to basic emergency obstetric care have a significant effect on birth preparedness and complication readiness, skilled care use and neonatal care practice and have non-significant effect on neonatal mortality. The individual variables related to intra-partum conditions and care as well as neonatal conditions and care have significant effect on neonatal mortality.

This study identified place of residence, access to health centre, maternal education, husband‘s occupation and wealth quintiles as socio-demographic and economic related determinants of birth preparedness and complication readiness, skilled care use and neonatal care practice. In addition, the study identified knowledge of key danger signs during labour and delivery and ANC visits as important determinants of BP and CR and skilled care use. Gravida and inter-birth interval were among maternal obstetric factors affecting skilled care use and neonatal care practice.

Birth order, ANC use, place of delivery, gestation age at birth, premature rupture of membrane, occurrence of complication during labour, twin births, size of neonate at birth and neonatal care practice were the specific factors identified as determinants of neonatal mortality in this study. The study also identified birth asphyxia, neonatal infections and prematurity as the major causes of neonatal death in the study area.

9. RECOMMENDATIONS

Based on the findings of the study, the following recommendations are forwarded to respective responsible bodies.

- **Policy makers: The Federal Ministry of Health, The Regional Health Bureau and The Zonal Health Desk**
  - Ensuring equity in health care for both urban and rural women by increasing access to health facilities and availing means of transportation (ambulances) for labouring mothers.
  - Strengthening the community-based interventions by health extension workers and also design more interventions to improve the knowledge of key obstetric danger signs, promote favourable attitude, improve the ANC and skilled care use and reduce the delays in care-seeking for obstetric complications.
  - Work in collaboration with other sectors like Road and Transportations Authority and Ministry of education in order to improve access to all weather roads and female education for sustainable changes.

- **District level health managers and program implementers**
  - Design appropriate context specific Information Education and Communication (IEC) and Behaviour Change Communication (BCC) both at the facility and at the community level to improve service use and minimize the existing barriers.
  - Follow the routine activities of the health facilities in order to assess whether the complaint of mothers on quality of care are real problems or perceived in order to improve the quality of care and meet the needs of the users.
  - Work closely with the communities in order to have problem-oriented and need-based program planning and implementing.

- **Health facilities**
  - Regularly assess and improve the quality of care to meet the demand of the clients (skilled human power, waiting time, appropriate record keeping, timely referral and referral arrangement)
  - Strengthen IEC and BCC programs on key danger signs, maternal health care use and neonatal care practices.

- **The health extension workers**
  - Strengthen community based IEC and BCC on key danger sings, ANC use, skilled care use and neonatal care practices
  - Assist families and pregnant women in preparing for birth and its complications including savings.

- **The community, family and individual woman**
  - Discuss the issues of maternal and neonatal care among themselves in order to develop comprehensive knowledge and develop favourable attitude on maternal and neonatal care.
  - Should cooperate and actively participate in community-based IEC and BCC interventions
  - Establish community based saving mechanisms for obstetric emergencies

- **Local NGOs and private sectors**
  - Strengthen maternal and child health programs and services by providing capacity building, including budget, infrastructure, ambulance, conducting trainings and IEC and BCC interventions.

- **Researchers**
  - Should conduct studies to identify more health care system related factors and quality of care, which were not addressed in this study.
  - Facility-based identification of causes of neonatal death, which is supported by clinical diagnosis and laboratory investigations to address the limitations of verbal autopsy for further interventions.

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12. APPENDICES

Annex 1: Published articles and submitted manuscripts

Annex 1.1. Tura G, Fantahun M, Worku A. The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. *BMC Pregnancy and Childbirth* 2013; 13:18 doi:10.1186/1471-2393-13-18 **(Published).**

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RESEARCH ARTICLE Open Access

The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis

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Abstract

Background: Though promising progress has been made towards achieving the Millennium Development Goal four through substantial reduction in under-five mortality, the decline in neonatal mortality remains stagnant, mainly in the middle and low-income countries. As an option, health facility delivery is assumed to reduce this problem significantly. However, the existing evidences show contradicting conclusions about this fact, particularly in areas where enabling environments are constraint. Thus, this review was conducted with the aim of determining the pooled effect of health facility delivery on neonatal mortality.

Methods: The reviewed studies were accessed through electronic web-based search strategy from PUBMED, Cochrane Library and Advanced Google Scholar by using combination key terms. The analysis was done by using STATA-11. I^2 test statistic was used to assess heterogeneity. Funnel plot, Begg's test and Egger's test were used to check for publication bias. Pooled effect size was determined in the form of relative risk in the random-effects model using DerSimonian and Laird's estimator.

Results: A total of 2,216 studies conducted on the review topic were identified. During screening, 37 studies found to be relevant for data abstraction. From these, only 19 studies fulfilled the preset criteria and included in the analysis. In 10 of the 19 studies included in the analysis, facility delivery had significant association with neonatal mortality; while in 9 studies the association was not significant. Based on the random effects model, the final pooled effect size in the form of relative risk was 0.71 (95% CI: 0.54, 0.87) for health facility delivery as compared to home delivery.

Conclusion: Health facility delivery is found to reduce the risk of neonatal mortality by 29% in low and middle income countries. Expansion of health facilities, fulfilling the enabling environments and promoting their utilization during childbirth are essential in areas where home delivery is a common practice.

Keywords: Neonatal mortality, Health facility delivery, Systematic review, Meta-analysis

Background

The fourth Millennium Development Goal (MDG_4) calls for reducing the under-five mortality rate by two-thirds between 1990 and 2015. However, only four years reaming for the deadline, only 41% decline in under-5 mortality rate has been achieved globally till 2011. As a result, about 7 million children died before their 5^{th} birthday in the year 2011 worldwide. From these, about 5 million died before the age of one and nearly 3 million died within the first 28 days of birth. This indicated that 43% of under-five deaths and 60% of infant deaths were accounted by the neonatal mortality [1]. This pointed out that it is difficult to achieve the desired target for the reduction of infant and under-five mortality without particular focus on neonatal mortality.

More than 98% of these deaths occurred in the low and middle income countries. Sub-Saharan Africa is, by far, the region of the world with the highest level of child as well as neonatal morbidity and mortality and remained the most troubling geographic area. In this region, 1 in 9 children dies before age five, more than 16 times the average for the developed regions (1 in 152). Similarly, this region has the highest risk of death in the first month of life and is among the regions showing the least progress [1,2].

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Most of these deaths were caused by infectious diseases, pregnancy-related complications, delivery-related complications including intra-partum asphyxia, birth trauma, and premature birth which can easily be prevented by skilled care during delivery and immediate neonatal period [1,3,4].

Skilled care during delivery has been recommended by World Health Organization (WHO) and the safe motherhood to improve the care provided to mothers during childbirth as it has a direct effect through prevention of infection, birth trauma, and asphyxia. Skilled care during labor is necessary to help normal things remain normal and to rapidly detect and deal with complications [5-8].

Similarly, many institutions and researchers have a doubt and have been questioning the safety of home delivery in the absence of skilled attendants. They strongly emphasize the importance of the place where a delivery takes place as complications that might arise during delivery need immediate action. They have a view that being at the right place at the time of delivery considerably increases the chances of neonatal survival [9,10].

On the other hand, currently, there is a shift to provide skilled delivery care at the community level including at home. In the developed countries' setup such as, Australia, England and the Netherlands, it has been evidenced that safe delivery can be provided at home provided that the enabling environments are in place. As a result, many authors and institutions have been advocating that it is the right of women to choose where to give birth whether at home or at health facility [11-14].

However, in the middle and low-income countries' setup where there are constraints of enabling environments, the quality and safety of cares are the areas of concern. To provide quality and safe delivery care, skilled attendants need supportive contexts in which to provide care. These include a supportive legal and regulatory framework, access to essential equipment and drugs, and a functioning referral system. As evidenced by safe motherhood studies in some low and middle income countries like Benin, Rwanda, Ecuador and Jamaica, the contribution of enabling factors and essential elements to health workers' performance is critical [15-18]. Thus, thinking these enabling environments, the safety of home delivery is a great concern.

To come up with concrete evidence regarding the effect of health facility delivery on neonatal mortality, it is very important to have a systematic review and meta-analysis, particularly for the low and middle income countries. But, in recent years, even though there are some local studies, systematic review and meta-analysis of such studies are very scarce. The existing very few reviews were limited to the developed countries and compared only planned home births with planned hospital births. Moreover, they focused on perinatal outcomes and less attention to neonatal mortality [19,20].

Thus, the purpose of this systematic review and meta-analysis was to determine the pooled effect of health facility delivery on neonatal mortality by reviewing a pool of evidences from studies conducted all over the world.

Methods

Search strategy and evaluation of studies

Studies for this review and meta-analysis were accessed through electronic web-based search by using EndNote software. To access the records the following combination key terms were used: place of birth AND neonatal mortality, place of delivery AND neonatal mortality, health facility delivery AND neonatal mortality and home delivery AND neonatal mortality. The main databases searched were PUBMED, Cochrane Library for systematic reviews and Advanced Google Scholar. WHO databases were also searched. After identifying key relevant articles their references were also looked into (ancestor search strategy). Similarly, other studies which cited them were looked on line (descendent search strategy).

Inclusion criteria

- *Design*: Because of ethical issues, Randomized Controlled Trial (RCT) Studies were limited on the review topic. As a result, all observational studies that assessed the relation between place of birth and neonatal mortality were included.
- *Publication status*: Both published and unpublished or grey literatures including Master's and other thesis were included.
- *Language*: Only articles published and grey literatures reported in English language were included because of inability to read and understand other languages.
- *Publication or report year*: Though 5–10 years back is preferred for systematic review and meta-analysis, publications or reports made from January 1980-October 2012 were identified here because of the limited number of existing studies on the topic that best fit for the review.

Exclusion criteria

Articles in which the exposure and outcome variables were not clearly indicated were excluded. In addition, studies that did not use appropriate sample size determination or sampling methods and studies that compared planned hospital births (with high risk) and planned home births (low risk) or provided particular intervention for home delivery and used this intervention as a means of classification were also excluded.

Data abstraction

This review was conducted from October 15–30, 2012. The review was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement having 27 items Checklist [21]. The relevance of the reviewed studies was checked based on their title, objectives, methods and key variables. Initially, by using the above stated combination key terms, studies conducted on topics related to the review title were retrieved.

Then, after excluding duplicated retrievals, studies or reports not found to be relevant for the review were excluded. For the rest, abstracts were accessed and screened based on the independent and dependent variables under review (place of birth and neonatal mortality). Studies that were found to be non-relevant were excluded during this screening. Full text articles or reports were accessed for the reaming. Based on the pre-set inclusion and exclusion criteria, eligibility of the studies was assessed. Two of the authors independently conducted the review and consensus was reached through discussion when there were differences. Some articles did not have adequate data in which case the corresponding authors were contacted and necessary data were obtained.

Data analysis

The necessary information was extracted from each original study by using a format prepared in Microsoft Excel spreadsheet and transferred to STATA/SE for windows version 11 for the meta-analysis. Heterogeneity among the original studies was checked by using I^2 test statistic. As the test statistic showed significant heterogeneity among studies (I^2 = 97%, p<0.001) in the fixed-effects model, random-effects model was used to estimate the DerSimonian and Laird's pooled effect. The pooled effect was expressed in the form of relative risk.

Publication bias was checked by using funnel plot asymmetry and statistical significance test by Begg's rank correlation and Egger's linear correlation in random-effects model. As the results of the test suggested possible existence of significant publication bias (p=0.01 in Egger's test), the final effect size was determined by applying trim and fill analysis in the random-effects model.

Results

Description of original studies

A total of 2,330 records related to the review topic were accessed. After removing duplicated retrievals, 2,216 records remained, of which 1,942 were excluded during the initial assessment as their titles were found to be non-relevant. For the remaining 274 records, abstracts were accessed and screened. However, 237 were excluded because, the abstracts were not relevant based on the exposure and outcome variables. As a result, 37 full text articles/reports were accessed and assessed for eligibility based on the pre-set criteria. Finally, 19 studies fulfilled the eligibility criteria and included in the qualitative systematic review and quantitative meta-analysis.

Six studies, a case control study in Iran [22], secondary data analysis from Demographic and Health Survey (DHS) in Pakistan [23], RCT in Nepal [24], secondary data analysis in Bangladesh [25], case control study in Zimbabwe [26], and population based retrospective study in Haryana, India [27] were excluded because they did not have enough information for the meta-analysis, i.e., the number of total live births and number of neonatal deaths were not separately indicated and compared for facility delivery and home delivery.

Eight studies, prospective cohort studies in North America [28], Canada [29-31], England [32], Sweden [33], cross-sectional study in England and Wales [34] and secondary data analysis in the Netherlands [35] were excluded because these studies compared planned home births (assumed to have low risk) and planned facility deliveries (high risk) which were different from what this review and analysis intended to compare. This review intended to measure the difference in the occurrence of neonatal mortality regardless of certain interventions based on certain risks. In addition, these studies tried to measure perinatal mortality as primary outcome which is different from the outcome for this review, neonatal mortality.

Three studies, secondary data analysis in Democratic Republic of Congo [36], DHS analysis in Indonesia [37], and cross-sectional study in Bangladesh [38], were excluded because the outcome measure was perinatal mortality which is different from the outcome measure of this review (neonatal mortality). One cohort study in Bangladesh [39] was also excluded because of some methodological limitations. The study compared 917 home deliveries with 17 health facility deliveries. During the review, the authors hesitated for the sufficiency of the 17 health facility delivery for comparison with the 917 home deliveries and decided to exclude (Figure 1).

Out of the 19 studies that were eligible and included in the systematic review and meta-analysis, almost all (18/19) were from low and middle income countries (Africa and Asia). Nine were from Africa: Nigeria [40,41], Uganda [42], Malawi [43], Egypt [44], Ghana [45], Tanzania [46], Ethiopia [47] and Burkina Faso [48]. Nine were from Asia: China [49], India [50,51], Iran [52], Vietnam [53,54], Indonesia [55] and Pakistan [56,57]. Only one was from Europe, Italy [58]. The publication year of these studies ranged from 1988–2012. However, the majority (14/19) of the studies were published in the last five years (2008–2012).

Regarding study design, nine were cross-sectional, five were prospective cohort study, four were case–control

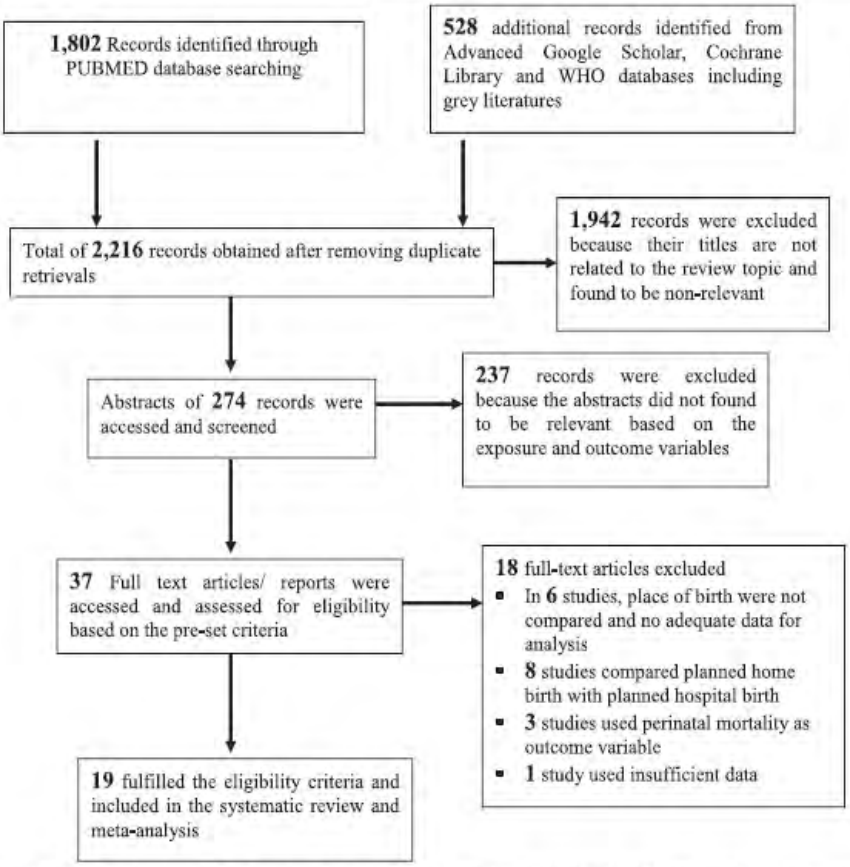

Figure 1 Flow chart showing the procedure of selecting studies for the systematic review and meta-analysis, 1988-2012.

study, and only one was community trial. The original sample size for each study ranged from 300 in case–control study in India to 898,360 in cross-sectional study in China.

In all the 19 studies included in the review and meta-analysis, a total of 1,606,805 live births were involved. Of whom, 18,186 died within 28 days of birth, making weighted neonatal mortality rate to be 11.32 per 1000 live births. When this is stratified by the place of birth, 1,504,450 were born in health facilities among whom, 14,821 died within 28 days of birth, making weighted neonatal mortality rate among facility deliveries to be 9.85 per 1000 live births. Whereas, 102,355 were born at home among which 3,365 died within 28 days of birth, making weighted neonatal mortality rate among home deliveries to be 32.88 per 1000 live births (Table 1).

Pooled effect size

The pooled effect size of neonatal mortality among health facility delivery in the form of relative risk was 0.40 (95% CI: 0.39, 0.42) as compared to home delivery in the fixed effects model. However, the I^2 test showed significant heterogeneity among studies (I^2 = 97.0%, $p < 0.001$). As a result, random effects model was used to determine the effect size. In this model, among the 19 studies included in the analysis, 10 showed statistically significant association between place of delivery and neonatal mortality and the rest 9 showed non-significant. The pooled effect size by the random-effects model became 0.64 (95% CI: 0.48, 0.85) for health facility delivery as compared to home delivery (Figure 2).

Publication bias was checked by using funnel plot asymmetry as well as Begg's and Egger's test of significance. On visual observation, the funnel plot found to be asymmetric. But, the Begg's test showed no significant rank correlation with Kendall's score of −31 and p=0.28. This did not support the funnel plot asymmetry, probably because of small number of studies. As a result, Egger's test of linear correlation for absolute test was considered. This showed positive significant liner correlation with r = 2.81 (95% CI: 1.10, 4.52) and p=0.003, suggesting significant publication bias. This highlighted that studies with larger sample sizes having larger effect sizes might have been published and included in the review and meta-analysis. As a result, trim and fill analysis was done to adjust the final effect size. After trim and fill

Table 1 List of 19 studies included in the meta-analysis on the effect of health facility delivery on neonatal mortality, 1988-2012

S/N	Author(s) & year of publication/report	Country	Design	Sample size	Health facility		Home	
					Live-births	Neonatal deaths	Live-births	Neonatal deaths
1	Feng *et al.*, 2011	China	Cross-sectional	898,360	840,622	6,592	57,738	1,664
2	Parazzine *et al.*, 1988	Italy	Cross-sectional	638,438	622,381	6,488	16,057	275
3	Owa *et al.*, 1998	Nigeria	Cross-sectional	7,225	5,741	653	1,484	285
4	Nathan *et al.*, 2012	Tanzania	Prospective cohort	8,593	5,146	188	3,447	111
5	McDermott *et al.*, 1996	Malawi	Prospective cohort	3,860	2,251	131	1,609	133
6	Okantey, 2008	Ghana	Cross-sectional	536	264	69	272	107
7	Titaley *et al.*, 2008	Indonesia	Cross-sectional	15,800	5,948	96	9,852	152
8	Sharifzadeh *et al.*, 2008	Iran	Case Control	468	227	68	241	88
9	Nga *et al.*, 2012	Vietnam	Community trial	14,453	13,003	161	1,450	72
10	Upadhyay *et al.*, 2012	India	Nested case control	5,444	2,871	102	2,573	84
11	Malqvist *et al.*, 2010	Vietnam	Case control	782	599	80	183	58
12	Oti *et al.*, 2011	Nigeria	Cross-sectional	5,708	2,009	65	3,699	122
13	Joshi, 2003	India	Case control	300	126	27	174	73
14	Tesfaye 2003	Ethiopia	Cross-sectional	1,462	837	27	625	41
15	Jehan *et al.*, 2009	Pakistan	Prospective cohort	1,121	893	43	228	10
16	Dialo *et al.*, 2011	Burkina Faso	Prospective cohort	864	308	10	556	30
17	Nankabirwa *et al.*, 2011	Uganda	Prospective cohort	835	490	7	345	11
18	Ayzen *et al.*, 2010	Pakistan	Cross-sectional	565	317	11	248	4
19	Seedhom *et al.*, 2008	Egypt	Cross-sectional	1,991	417	3	1,574	45
			Total	**1,606,805**	**150,4450**	**14,821**	**102,355**	**3,365**

in the Random-effects model, the final pooled effect size was 0.71 (95% CI: 0.54, 0.87) with p<0.001. This shows that there is a significant difference in the rate of neonatal mortality between neonates born at health facility and at home (Figure 3).

To identify the possible causes of heterogeneity, stratified analysis was done based on the study designs, sample size and proportion of health facility delivery. In the fixed effects model, except cohort study, all the designs found to show significant effects. However, in the random effects model, cross-sectional studies and community trail studies were found to show significant effect whereas case–control studies and cohort studies did not show significant effects. The stratified analysis also revealed that there were differences in the effect size as the sample size differs. The analysis showed that the higher the sample size (>10,000) the stronger the effect size (Table 2).

Similarly, the difference in the coverage of health facility delivery resulted in variation in effect size. When proportion of health facility delivery is less than 50%, the effect size becomes 0.74 (95% CI: 0.59, 0.94), when the proportion of health facility delivery is 50% or above the effect size becomes 0.61 (95% CI: 0.43, 0.87) in the random effects model, however, in the fixed effects model this variation is much more significant (Table 2). With this, the difference in study designs, the difference in sample sizes and the difference in the proportion of health facility delivery are likely to be the causes for the heterogeneity. It was also planned to stratify based on level of development as high income countries and middle and low income countries. However, nearly all (18/19) were from the middle and low income countries and this could not be done.

Discussions

This systematic review and meta-analysis tried to assess the pooled effect of health facility delivery on neonatal mortality.

The findings revealed that health facility delivery has statistically significant effect on neonatal mortality. It has resulted in 29% reduction in risk of neonatal mortality. As nearly all of the studies included in meta-analysis were from low and middle income countries, this figure can best applies for these countries. This effect had also been observed in some prior reviews. The systematic review and Delphi estimation conducted on more than 20 studies in developing countries showed that comprehensive emergency obstetric care and basic emergency obstetric care resulted in a reduction of

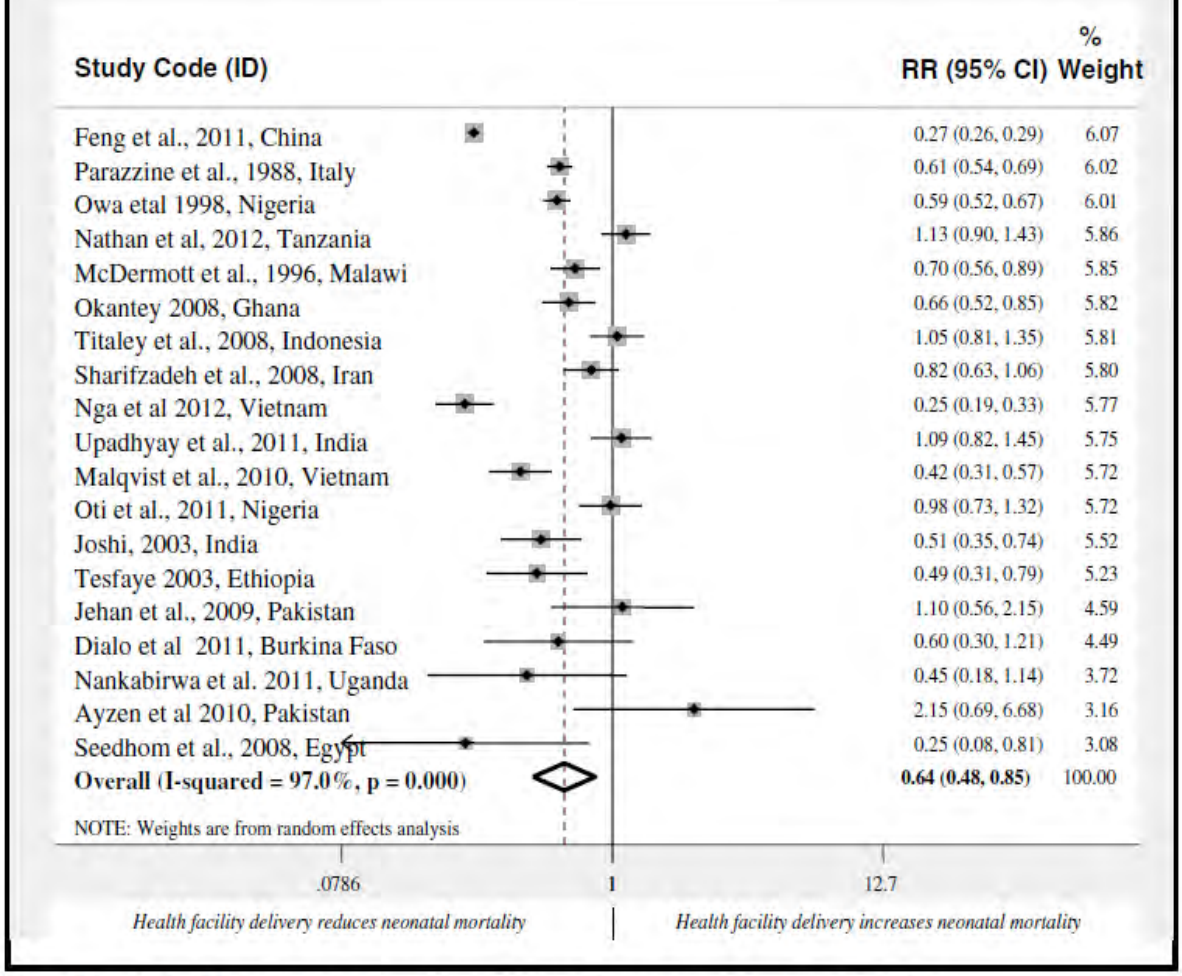

Figure 2 Forest Plot of 19 studies on the effect of health facility delivery on neonatal mortality, 1988-2012.

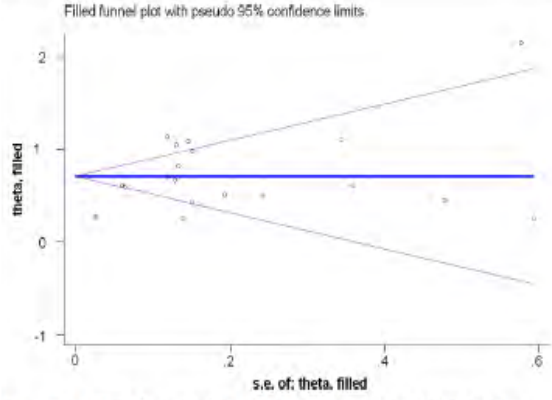

Figure 3 Filled funnel plot of the 19 studies included in the meta-analysis on the effect of health facility delivery on neonatal mortality, 1988-2012.

intra-partum related neonatal deaths by 85% and 40% respectively [59].

Individual country's experience also supports this finding. Portugal [60] and Chile [61] for example have shown significant reduction in neonatal mortality by expanding obstetric facilities and increasing the coverage of health facility delivery. This could be because of the fact that clean and safe delivery can be given at health facility. This in turn avoids trauma, infection and other risks that lead to morbidity and mortality of neonates.

Even though, a total of 2,216 studies were accessed, 37 original studies fit to the review topic and only 19 of them fulfilled the selection criteria. Among the 19 included studies, 14 were published in the last five years. This shows that the issue of neonatal mortality reduction through institutional delivery is a relatively recent research agenda. Because of the ethical issues, RCT studies were almost non-existent on this topic. As a result,

Table 2 Stratified analysis of the 19 studies included in meta-analysis based on study designs, sample size and proportion of health facility deliver, 1988-2012

Stratifying variable	Sample size	Fixed-effects RR (95% CI)	Random-effects RR (95% CI)
Study design			
Prospective cohort	15,273	0.87 (0.75, 1.82)	0.82 (0.59, 1.14)
Case-Control	6,994	0.70 (0.60, 0.81)	0.67 (0.43, 1.03)
Cross-Sectional	1,570,085	0.37 (0.35, 0.38)	0.63 (0.41, 0.95)
Community trial	14,453	0.23 (0.19, 0.33)	0.23 (0.19, 0.33)
Sample size			
<1,000	4,350	0.62 (0.54, 0.71)	0.62 (0.47, 0.81)
1,000-5,000	8,434	0.63 (0.52, 0.78)	0.56 (0.36, 0.85)
5,001-10,000	26,970	0.76 (0.69, 0.83)	0.91 (0.62, 1.33)
>10,000	1,567,051	0.32 (0.31, 0.34)	0.46 (0.25, 0.83)
% of health facility delivery			
<50%	25,667	0.80 (0.71, 0.90)	0.74 (0.59, 0.94)
≥50%	1,581,138	0.37 (0.36, 0.39)	0.60 (0.43, 0.87)

observational studies were included. Many authors witnessed that observational studies can give valid findings with moderate effects when RCTs are not available to provide strong evidences [62-64]. With this, the finding of this systematic review and meta-analysis is taken as valid in showing moderate evidence.

The stratified analysis showed that the effect is higher in areas where the coverage of health facility delivery is high. When health facility delivery converge is above 50%, there is a reduction of about 40% in neonatal mortality as compared to 26% reduction when health facility delivery is less than 50%. This might be because, in areas where there is low coverage of health facility delivery, women usually give birth at home and go to the health facility after encountering some problems during labor. As a result, the child to be born is more likely to have some health problems and die during the neonatal period.

For program implication, in middle and low income countries, the issues of enabling environments need special emphasis while promoting home delivery. Because, in areas where there is shortage of equipments, drugs and other supplies together with problem of emergency referral, the safety of home delivery in reducing neonatal mortality may be under question. Thus, in such areas encouraging women to give birth in health facilities where necessary enabling environments are in place is very essential. Moreover, health facility delivery will also create an opportunity for the mother and the newborn to receive immunization and other necessary health information on preventive measures that may have an effect on preventing neonatal death.

Because of the variation in the design, sample size and the proportion of health facility delivery, significant heterogeneity among the studies was observed. As a result, random effects model was used to estimate the final pooled effect. Similarly, because of the existence of significant publication bias, trim and fill analysis was used. These might have underestimated the true effect of health facility delivery on neonatal mortality. So, it is important to note of this while interpreting and using this findings.

This systematic review and meta-analysis may have limitations as it was limited to publications and reports made in English language and observational studies. In addition, because of the nature of the meta-analysis that uses aggregated group data, the skill of the delivery attendant and other confounding factors were not controlled. This might have affected the effect size. Therefore, the findings of this systematic review and meta-analysis should be interpreted in the context of both inherent limitations of the original studies and the current reviews and analysis.

Conclusions and recommendations

This meta-analysis found statistically significant association between place of delivery and neonatal mortality. In the low and middle income countries, health facility delivery was found to reduce the risk of neonatal mortality by 29%. Therefore, expansion of health facilities and promotion of their utilization are essential in areas where home delivery is a common practice and enabling environments are scarce. In addition, longitudinal studies need to be encouraged in areas where studies are lacking to come up with a more precise effect.

Competing interests

The authors declare that they do not have any competing interest concerning the findings of the study.

Authors' contributions

TG involved in the conception of the study. TG, FM and WA conducted the review and screened the records for eligibility. TG carried out data extraction and conducted statistical analysis under the supervision of FM and WA. TG prepared the initial report which latter be read and edited by FM and WA. The final manuscript were read and approved by all authors.

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Annex 1.2. Tura G, Fantahun M, Worku A. Factors affecting birth preparedness and complication readiness in Jimma Zone, Southwest Ethiopia: a multilevel analysis. *Pan African Medical Journal* 2014; 19:272. doi:10.11604/pamj.2014.19.272.424. **(Published and PDF under progress).**

Factors affecting birth preparedness and complication readiness in Jimma Zone, Southwest Ethiopia: a multilevel analysis

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Abstracts:

Background: *Birth preparedness and complication readiness have been considered as a comprehensive strategy aimed at promoting the timely utilization of skilled maternal health care. However, its status and affecting factors were not well studied at different levels in the study area. Thus, this study was aimed to fill this gap by conducting community based study.*

Methods: *A cross-sectional study was conducted among randomly selected 3612 pregnant women from June-September 2012. The data were collected by interviewer administered structured questionnaire and analyzed by SPSS V.20.0 and STATA 13. Mixed effect multilevel logistic regression model was used to identify factors associated with birth preparedness and complication readiness.*

Results: *The status of birth preparedness and complication readiness was 23.3% (95% CI: 21.8%, 24.9%). Being in urban residence and having health center within 2 hours distance were among the higher level factors increasing birth preparedness and complication readiness. Educational status of primary or above, husband"s occupation of employed or merchant, third or above wealth quintiles, knowledge of key danger signs during labour, attitude and frequency of antenatal care visits were among the lower level factors found to increase the likelihood of preparation for birth and its complications.*

Conclusions: *The status of birth preparedness and complication readiness was low in the study area. Both community level and individual level factors had important program implications. Socio demographic, economic, knowledge of key danger signs, attitude and ANC use were identified as associated factors. Improving ANC, giving special emphasis to danger signs and community based IEC/BCC are recommended.*

Key words: *Birth preparedness, complication readiness, multilevel analysis, Jimma Zone, Southwest Ethiopia*

Introduction:

Globally, about 287,000 mothers die each year because of problems related to pregnancy and child birth. About 99% of this occurs in developing countries. Sub-Saharan Africa (56%) and Southern Asia (29%) accounted for 85% of the global burden of maternal death. With this disparity, the maternal mortality rate in developing countries is more than 15 times higher than in the developed regions [1]. While almost all developed countries have achieved the desired three-fourth reduction of maternal mortality by 2015, many of the developing countries are on track. However, majority of the resource limited countries in Sub-Saharan Africa have shown the slowest progress with an average annual rate of decline of 2.6% [2, 3].

Ethiopia is one of the Sub-Saharan African countries with high maternal mortality ratio (MMR) and very slow progress. The MMR in the Ethiopian Demographic and Health Survey (EDHS) 2011 was 676 per 100,000 live births which had shown non-significant decline as compared to 673 and 871 per 100,000 live births in EDHS 2005 and 2000 respectively. As a result, improving maternal health status so as to achieve the intended target is among the top priority areas of the country [4-6].

The high maternal mortality and slow progress in low and middle income countries, in part, are explained by the low coverage of maternal health care and the three delays to health care seeking behaviour of mothers. These problems are again influenced by demographic, poor socio-economic status and poor quality of services [7-9]. To address these problems, birth preparedness and complication readiness (BP and CR) has been considered as a comprehensive strategy aimed at promoting the timely utilization of skilled maternal health care and addresses the three delays to care-seeking for obstetric emergencies. It promotes active preparation and decision-making for births, including pregnancy and postpartum periods, by shared responsibilities of pregnant women, their families, the community and the service providers [10, 11].

The elements of birth preparedness and complication readiness at individual level include: plan for where to give birth, plan for a skilled birth attendant, plan to save money, plan for transportation and identification of compatible blood donors in case of emergency. These enable the woman and her family for timely use of skilled maternal and neonatal care based on the theory that preparing for childbirth and being ready for complications reduce delays in obtaining these cares [10].

Though we have limited studies in Ethiopia, the existing evidences show that the status of birth preparedness and complication readiness is low. A cross sectional study conducted in Adgrat town in 2006 revealed that only 22% of the respondents were prepared for birth and its complications [12]. Similarly, a cross-sectional study conducted in Aleta Wondo District, South Ethiopia, in 2007 found that only 17% of the respondents were prepared for birth and its complications [13]. Thus, it is timely and very crucial to have up-to-date information on the status of birth preparedness and complication readiness and determinant factors at different levels for policy and program implications. However, studies on this issue are very limited in Ethiopia and non-existent in the study area. Even, the existing studies didn‘t look at the factors at different levels. Therefore, this study was conducted to fill this gap by identifying the factors affecting birth preparedness and complication readiness at the different levels (community, household and individual levels) by applying multilevel analysis of community based study in Jimma zone.

Methods:

Study design and setting

This is a community based cross-sectional study conducted in Jimma Zone from June-September 2012. Jimma Zone is one of the 17 Zones of the Oromia Regional State of Ethiopia. The capital of the Zone, Jimma Town, is located at 356kms Southwest of Addis Ababa. The Zone has a total of 17 rural districts (‗Woredas') and two town administrations. Based on the 2007 national population census conducted by the Central Statistics Agency (CSA) of Ethiopia, the Zone has a total population of 2.6 million. About 11.3% were urban inhabitants and the rest were rural residents [14, 15]

Population, Sample size and sampling technique

The populations for this study were pregnant women. The sample size was determined by using Epi-Info V.3.5.1 by considering two sample comparison of proportions based on the following assumptions. Among all the factors considered, antenatal care (ANC) was found to give the largest sample size. The prevalence of birth preparedness and complication readiness among mothers who attended ANC is estimated to be 22% (p_1=0.22) and among those who didn't attend ANC is to be 13% (p_2=0.13) [13]. 95% level of confidence and 90% power were considered. The prevalence of ANC in the general population in same study was 45%. As a result, a ratio of 1:1 was used (r = 1). As multistage clustered sampling method was used, a design effect of 2 was considered. Finally, 10% was added for non-responses and the final sample size became 1650. However, this study was part (baseline) of a big longitudinal study to determine the effect of maternal and neonatal health care on neonatal health status in which 3612 pregnant women have been on follow up. As a result, all the 3612 pregnant women were included in the analysis for this study.

Multi-stage clustered sampling technique was used to identify pregnant women for the study. At first stage, the Zone was stratified as rural districts (17 in number) and town administrations (2 in number, Jimma and Agaro). Then, 5 districts were selected by simple random sampling from the 17 districts. At second stage, all the selected 5 districts were clustered by ‗*Kebele*s' (A ‗*Kebele*' is the smallest administrative unit having 5000 population in average) and stratified in to urban and rural ‗*Kebele*s'. Then, by simple random sampling method, 9 rural ‗*Kebele*s' and 2 urban *Kebele*s were selected from each selected district. This number of *Kebele*s was determined based on expected number of pregnant women per *Kebele*. Jimma town administration and Agaro town administration have 13 and 5 ‗*Kebele*s' respectively and all were included purposefully. With this, a total of 73 ‗*Kebele*s' (clusters) were included in the study. Then, for all selected ‗*Kebele*s' pregnant women were enumerated by using house-to-house visit and all obtained were included in the study.

Data collection process

Pre-tested interviewer administered structured questionnaire was adapted from the safe motherhood questionnaire developed by maternal and neonatal health program of JHPIEGO [11]. The indicators for the wealth index were adapted from EDHS [6]. The questionnaire was prepared in English, then translated to local languages ‗Afan Oromoo' and Amharic and back translated to English by different experts to check its consistency. Females, who had completed 10^{th} grade or above, were recruited, trained and collected the data. The data collection process was supervised strictly by trained supervisors and principal investigators. To control the quality of data, in addition to training, pre-test, supervision and use of local languages, the inter-item consistency of the indicators to measure the composite score of BP and CR was checked by using Chronbach-alpha at 0.7 cut-off point. Moreover, data entry was done by using Epidata to control illegal values and skip patterns.

Data analysis

The collected data were coded and entered into Epidata V.3.1. and exported to SPSS for windows version 20.0 for cleaning, editing and analysis. Descriptive analysis was done by computing proportions and summary statistics. Socioeconomic quintiles were determined by using Principal Component Analysis (PCA). As Jimma and Agaro town administrations were both purposefully included, the status of BP and CR was estimated by calculating weighted percentage based on the complex sample survey procedure by considering probability of exclusion at each stage and non responses in order to avoid over estimation.

Bivariate analysis was done by using cross tabulation to see associations between the independent and dependent variables. Then, all variables having P-value <0.25 were considered as candidates for the mixed effect multilevel logistic regression model. Because of the multi-stage clustered sampling procedure, mixed effects multilevel logistic regression model was used by using STATA 13. This model was preferred in order to avoid the clustering effects as well as ecological fallacy. *Kebele*s were considered as clusters and *Kebele* level variables were taken as higher level (level-2). Mothers were nested within their households and maternal individual variables and household characteristics were taken as lower level (level-1) variables (Table 1). Goodness of fit of the multilevel model was tested by the log likelihood ratio (LR) test. To evaluate the extent of the cluster variation in influencing BP and CR, intercept-only model was fitted as Logit (p_{ij}) = $\gamma_{00} + u_{0j}$ and Interclass Correlation Coefficient (ICC) was determined by using the following formula.

$$ICC(\rho) = \frac{\text{Variance between groups}(\delta^2\mu_0)}{\text{Variance between groups}(\delta^2\mu_0) + \text{Variance within group}(\delta^2 e)}$$

However, within group variance ($\delta^2 e$) is not directly obtained for dichotomous outcome variable; instead, it was estimated by $\prod^2/3 = 3.29$ as follows: $ICC = \delta^2\mu_0 / (\delta^2\mu_0 + \frac{\prod^2}{3})$

Then, to identify the determinate factors, the full model was fitted as: $Logit(p_{ij}) = \gamma_{00} + \gamma_{01} Z_j + \gamma_{10} X_{ij} + u_{0j} + u_{1j} X_{ij.}$ Where: $Logit(p_{ij})$=dependent variable at unit i in cluster j, X_{ij} = individual explanatory variable in cluster j, Z_j = group level explanatory variable, γ_{00} = fixed intercept, γ_{01} and γ_{10} = fixed slopes and u_{0j} and u_{1j} = random effects at level-2. Multicollinearity between the independent variables was assessed by using variance inflation factors (VIF) before interpreting the final output. But, no significant multicollinearity was detected as VIF for all variables were <5. In addition cross-level two-way interactions were checked, particularly between place of residence, access to health facilities and ANC visits. However, no significant interaction was detected (P>0.05 for each).

Ethical clearance

Ethical approval was obtained from the Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University as well as IRB of Oromia Regional State Health Bureau. Following this, formal letters and permissions were secured from all respective local administrators. Written informed consent was obtained from each respondent before actual data collection. Issues of confidentiality were maintained by removing any identifiers from the questionnaire. To protect vulnerable group, data collectors were trained to maintain confidentiality and provide necessary health information based on the need of the participants.

Results:

Socio-demographic characteristics

Of the total 3612 pregnant women included, 2716(75.2%) were rural residents. Majority, 2323(64.3%), lied in the age group of 20-29, with a mean age of 26.5±5.0 years. Oromoo were the predominant ethnic group, 3161(87.7%). The leading religion was Muslim, 3149(87.1%). Nearly all, 3589(99.4%) were in a marital union and more than half, 1955(54.1%) didn't attend any formal education. The great majority, 3413(94.5%), were housewives and farmer was the leading occupation of their partners 2566(71.0%) (Table 2).

Past Obstetric history

Gravida, number of pregnancies ever had, ranged from 1 to 9 among the respondents with a mean of 3.3±1.9. Similarly, number of live births ever had ranged from 1-8 with a mean of 2.8±1.6. Among those who ever had two or more pregnancies, 156(5.5%) and 203(7.2%) had life time history of abortion and stillbirth respectively. Nearly four-fifth, 2236(79.1%) had the last inter-pregnancy interval of 2-4 years with a mean of 3±1.3 years. Among those who had at least one delivery in the past, 1690(59.8%) had at least one ANC visit and only 406(14.5%) had given birth attended by skilled providers.

Knowledge of key danger signs

The three key danger signs during pregnancy: severe vaginal bleeding, swollen hands/face and blurred vision were spontaneously mentioned by 964(26.7%), 530(14.7%) and 1078(29.8%) respectively. However, only 227(6.3%) were able to spontaneously mention all the three key danger signs. The four key danger signs during labour and delivery: severe vaginal bleeding, convulsions, prolonged labour and retained placenta, were spontaneously mentioned by 1788(49.5%), 588(16.3%), 537(14.9%) and 545(15.1%) respectively. Very few, 133(3.7%), were able to mention all the four key danger signs spontaneously.

The three key danger signs during postnatal period: severe vaginal bleeding, foul smelling vaginal discharge and high fever were spontaneously mentioned by 1638(45.3%), 548(15.2%), and 436(12.1%) respectively. However, only 88(2.4%) were able to mention the three key danger signs spontaneously. The four key danger signs of neonates: difficult or fast breathing, small at birth, lethargy/unconscious and seizure/convulsion, were spontaneously mentioned by 1483(41.1%), 675(18.7%), 377(10.4%) and 243(6.7%) respectively. While, only 75(2.1%), were able to mention the four key danger signs (Table 3).

Attitude towards BP and CR

Attitude of the respondents was measured by using a composite variable of 8 items in a Likert-scale and those achieved above or equal to the mean score were rated as having favourable attitude. Based on this, 2202(61.0%) were found to have favourable attitude towards birth preparedness and complication readiness.

BP and CR practice

Among the five key elements of BP and CR practice, 2656(73.5%) planned to save money, 2174(60.2%) planned to arrange transport, 719(19.9%) planned to prepare blood donor, 1169(32.4%) planned to give birth in health facility and 791(21.9%) planned to be attended by skilled attendant for their current pregnancy. By considering 3 or more steps of the five parameters, 1245(34.5%) were found to fulfill the criteria and rated as well prepared for birth and its complications. However, after weighted analysis to avoid over estimation, the final status of BP and CR was found to be 23.3% (95% CI: 21.8%, 24.9%) (Table 3).

Factors affecting birth preparedness and complication readiness

Before running the full model, ICC (ρ) was calculated in the empty model and it was found to be 0.554 indicating that 55.4% of the variation is contributed by between cluster variation. The test of the preference of log likelihood Vs logistic regression was also strongly significant (P<0.0001). Then, the full model was run by including both the cluster level and individual level variables and the ICC (ρ) was reduced to 0.302. This again indicated that 30.2% of the variation is attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood Vs logistic regression was again strongly significant (P<0.0001) (Table 4).

After adjusting for confounders in the final two-levels mixed effects model, among the cluster level variables, place of residence and access to health centre were found to have statistically significant association with BP and CR practice. Women from urban residence (OR = 6.01; 95%CI: 2.56, 14.08) and women who were from *Kebele*s found within 2 hours travel on foot from health centre in average (OR = 2.93; 95%CI: 1.43, 6.02) were more likely to be prepared for birth and its complications.

Among the socio-demographic and economic characteristics considered as level-1, educational status, husband‘s occupation and wealth quintiles were found to have statistically significant association with BP and CR practice. Women who attended primary (OR=1.55; 95%CI: 1.24, 1.94), secondary (OR=3.13; 95%CI: 2.00, 4.91) or tertiary (OR=8.04; 95%CI: 2.14, 30.24) were more likely to be prepared as compared to women who didn‘t attend any formal education.

Women having husband who were employed (OR= 1.77; 95%CI: 1.14, 2.74) or merchant (OR=2.04; 95%CI: 1.40, 2.96) were more likely to be prepared as compared to women having farmer husband. Women in the third (OR=1.46; 95%CI: 1.06, 2.00), fourth (OR=1.24; 95%CI: 1.06, 1.72) or fifth (OR=1.56; 95%CI: 1.12, 2.19) wealth quintiles were more likely to be prepared as compared to women in the lowest quintiles.

Among the obstetric related factors considered at individual level, knowledge of key danger signs, attitude and frequency of ANC visits had significant association with BP and CR practice. Women who know all the four key danger signs during labour and delivery were more likely to be prepared for birth and its complications (OR=2.04; 95%CI: 1.22, 3.39). Similarly, having favourable attitude towards BP and CR was found to increase the likelihood of preparation significantly (OR = 1.73; 95%CI: 1.37, 2.18). ANC visit was also among the strong predictors of BP and CR. Having 1-3 visits (OR = 2.12; 95%CI: 1.67, 2.69) and greater or equal to 4 visits (OR=2.87; 95%CI: 1.98, 4.18) were found to increase the likelihood of preparation as compared to those who didn‘t attend ANC visit at all (Table 5).

Discussions:

As the occurrence of complications during the process of child birth are unpredictable, every woman needs to be aware of the key danger signs of obstetric complications during pregnancy, delivery and the postpartum period. This knowledge will ultimately empower them and their families to make prompt decisions to seek care from skilled birth attendants [11]. However, the knowledge of key danger signs in this study was found to be very low. The three key danger signs during pregnancy, the four key danger signs during labour and

delivery, the three key danger signs during postpartum period and the four key danger signs of neonates were spontaneously mentioned by 6.3%, 3.7%, 2.4% and 2.1% respectively which were very low. Similar problems were reported in other prior studies in Ethiopia and other African countries [12, 16-18].

This low level of knowledge of key obstetric danger signs in developing countries may be explained by the low coverage of ANC visits and inadequate number of visits. This may also indicate that less attention might have been given to key danger signs while giving health education and advice during ANC. In this study, 54.1% didn't attend any formal education and the other 36.6% attended only primary education. This low level of education might have also limited their access to information and contributed to this low level of knowledge.

In this study, 73.5% of respondents planned to save money and 60.2% planned to arrange transport which were relatively better. However, only 19.9% planned to arrange blood donor, 32.4% planned to give birth at health facility and 21.9% planned to be attended by skilled attendants which were still low. This level of preparation is better than the findings of other prior studies in the country. In the study conducted in Adgrat Town, North Ethiopia in 2006, 35.6% saved money, 3.2% identified a mode of transportation, 39.1% identified place of delivery and 10.5% identified skilled attendant at delivery [12]. Similarly, in the study conducted in Sidama Zone, South Ethiopia in 2007, 34.5% planed to save money, 7.7% planed to arrange transport, 2.3% planed to arrange blood donor and 8.1% planed to deliver in health facilities [13]. This might be due to the community based interventions by the government particularly home to home education by health extension workers in the last five years.

However, the findings of this study, particularly the preparation of health facility delivery and skilled delivery attendant, were lower than some other countries' study like Tanzania [18], Nigeria [19] and Burkina Faso [20]. This difference may be explained by the difference in socio-economic status, availability and accessibility of services or any other interventions in the countries.

The overall status of birth preparedness and complication readiness in this study was 23.3%. It is consistent with other priori studies in the country. In a study done in Adgrat town, North Ethiopia in 2006 and Sidama Zone, South Ethiopia in 2007, the status of birth preparedness and complication readiness were 22% and 17% respectively [12,13]. This suggests that in spite of many efforts by the government, the progress is slow.

In this study, the adjusted final multilevel model indicated 30.2% of the variation is explained by the cluster level variables. This means that 69.8% of the variation is contributed by the household and individual level factors. This indicated that both the community level and individual level factors were found to be important for program implications. However, more emphasis should be given to the individual and household level factors while addressing the problem of BP and CR.

Among the higher level factors, being in urban residence was found to increase the likelihood of preparation for birth and its complication by about six times in this study. Having health centres within 2 hours distance on foot in average was also found to increase the likelihood of preparation by about three times. This finding is inline with previous studies [12, 18). This may be explained by the fact that women in urban areas have access to health information

through different media and relatively low barriers due to distance and lack of transportations as compared to the rural women. Similarly, having nearby health facility increases access to health information and also reduces distance barriers.

Among socio-demographic and economic related factors, education, husband‘s occupation and wealth quintiles were the predictors of BP and CR in this study. Attending primary(1-8), secondary (9-12) and tertiary (12+) schools were found to increase the likelihood of preparation by about 1.5, 3 and 8 times respectively. Similarly, having partner who is employed or merchant increased the likelihood of preparation for birth and its complication as compared to those whose partners were farmers. Besides, wealth quintiles were found to be the other determinant factor. Being in the wealth quintile category of third and above was associated with increased preparation for birth and its complications.

This is in line with the findings of other study conducted in the country as well as other countries; where education, occupation and income were among the factors affecting birth preparedness and complication readiness [12, 18]. The reasons could be, having high education, being employed and merchant is directly related with high access to information and income which enable them to be prepared for birth and its complications.

Most importantly, Knowledge of key danger signs during labour and delivery, women‘s attitude towards BP and CR and ANC visit were found to be the determinant factors in this study. However, knowledge of key danger signs during pregnancy, post partum period and neonates were not found to have significant associations. This is in line with other studies in the country and abroad in which ANC visit and knowledge of danger signs were among the strong predictors of BP and CR practice [12, 13, 18]. This might be due to the advice about the risks of pregnancy and importance of BP and CR given during ANC. The health education during ANC also increases knowledge of danger signs and develops favourable attitude that enhance preparation for birth and its complications.

This study may have its own limitation because of the cross-sectional nature of the study to ascertain temporal relationship. In addition, some variables like wealth quintiles and indicators of attitude were subjective. Dichotomizing such composite variable may have its own limitations in identifying cut-off points. Possible efforts were made to use standard and as many variables as possible to make them objective.

Conclusions

This study revealed that the level of knowledge of key obstetric danger signs and the status of birth preparedness and complication readiness in the study area were very low. Place of residence, access to health centre, educational status, husband‘s occupation, wealth quintiles, knowledge of key danger signs, attitude and ANC visit were identified as factors affecting birth preparedness and complication readiness. Improving ANC, giving special emphasis to knowledge of key danger signs and BP and CR during health education and ANC counselling are recommended as a short term solutions. Women education, job and income generating activities to raise the socio-economic status of the women are recommended as long term interventions.

Competing interests

The authors declared that they have no competing interest.

Authors' contributions

GT involved in the conception of the study. GT, MF and AW involved in the design, data collection process, analysis and interpretations of the findings. GT prepared the initial manuscript which latter be read and edited by MF and AW. The final manuscript was read and approved by all authors.

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Table 1: Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, June-September, 2012

Variables	Descriptions	Measurements
Dependent variable		
Birth preparedness and complication readiness	A package of interventions composed of composite measure of 5 variables (planed to save money, planed to arrange transport, identified place of delivery, identified skilled attendant and identified blood donor)	Women were labelled as 'Yes =1' if planed otherwise 'No = 0'. Composite variable was computed by adding the five responses. Women who scored 3 or more 'Yes' responses were categorized as 'prepared' otherwise 'not prepared'
Level-2 predictor variables	**Communal (*Kebele*) characteristics**	
Place of residence	Women were asked whether they live in urban or rural residents	Urban *Kebele* was coded as '1' and rural *Kebele* was coded as '0'.
Average distance from health centre	Women were asked about the approximate distance from the nearest health centre on foot in munities. When they had difficulties, the data collector assisted in estimating the approximate time it takes	Average distance was computed for each *Kebele* and dichotomized as '≤2hours' and '>2hours'
Average distance from Hospital	Women were asked about the approximate distance from the nearest hospital on foot in munities. When they had difficulties, the data collector assisted in estimating the approximate time it takes	Average distance was computed for each *Kebele* and categorized as '≤2 hours', '>2-12hrours' or '>12hours'
Level-1 predictor variables	**Individual and household characteristics**	
Age	Age of women at interview was asked in completed years	Categorized in to7 groups by five-years interval, which later recoded in to three categories: '<20', '20-29' or '>29'
Ethnicity	The ethnic background of the women were asked and recorded	Each ethnicity was entered and later recoded as 'Oromo' and 'Others'. Others were merged because they were very few for logistic regressions.
Religion	The religious background of the women were asked	Each religion was entered and later recoded as 'Muslim' or 'Others'. Others were merged because they were very few for logistic regressions.
Educational status	Highest level of education attained by the respondent and her husband	Categorized in to 4 groups as 'no Formal Education', 'primary (1-8)', 'Secondary (9-12)' and 'tertiary (12^{+})'.
Occupational status	Current employment status and specific occupation of respondent and her husband	Categorized as 'housewife' ('farmer' for husbands), 'employed', 'merchant' and 'others'.
Wealth quintiles	Using EDHS questionnaire, house hold assets ownership were assessed and wealth index was computed by using principal component analysis (PCA)	The wealth status was categorized in to five groups and ranked from poorest to wealthiest quintile.

Table 1: description of variables continued....

Knowledge of key danger signs during pregnancy	Spontaneous response to the three key danger signs: severe vaginal bleeding, swollen hands/face and blurred vision were asked	For each key danger sign, 'Yes' was coded as '1' and 'No' was coded as '0'. After adding the three responses, women who responded 'Yes' to all the three danger signs (scored 3/3) were labelled as 'knowledgeable' and otherwise 'not knowledgeable'.
Knowledge of key danger signs during labour	Spontaneous response to the four severe vaginal bleeding, convulsions, prolonged labour and retained placenta were asked	For each key danger sign, 'Yes' was coded as '1' and 'No' was coded as '0'. After adding the four responses, women who responded 'Yes' to all the four danger signs (scored 4/4) were labelled as 'knowledgeable' and otherwise 'not knowledgeable'.
Knowledge of key danger signs during postnatal period	Spontaneous response to the three key danger signs: severe vaginal bleeding, foul smelling vaginal discharge and high fever were asked	For each key danger sign, 'Yes' was coded as '1' and 'No' was coded as '0'. After adding the three responses, women who responded 'yes' to all the three danger signs (scored 3/3) were labelled as 'knowledgeable' and otherwise 'not knowledgeable'.
Knowledge of key danger signs during postnatal period	Spontaneous response to the four key danger signs: difficult or fast breathing, small at birth, lethargy/unconscious and seizure/convulsion were asked	For each key danger sign, 'Yes' was coded as '1' and 'No' was coded as '0'. After adding the four responses, women who responded 'Yes' to all the four danger signs (scored 4/4) were labelled as 'knowledgeable' and otherwise 'not knowledgeable'.
Attitude towards BP and CR	Attitude of the respondents was measured by using a composite variable of 8 items in a Likert-scale	The responses were categorized as: '1=strongly disagree', '2=disagree', '3=indifferent', '4=agree' and '5=strongly agree'. Then, after creating composite variable after adding the 8 questions, mean score was determined. Those who scored above or equal to mean were labelled as having "favorable attitude' and otherwise 'non-favourable attitude'.
Gravida	Number of pregnancies a woman ever have including current pregnancy	Categorized in to three: 'primi gravida', 'gravid 2-4' and 'gravida 5 or above'
ANC frequency	Having health facility visit for pregnancy check up by skilled attendants during pregnancy.	Categorized in to three: 'no ANC visit at all', '1-3 ANC visits' and '≥4 ANC visits'

Table 2: Selected Socio-demographic characteristics of respondents, Jimma Zone, Southwest Ethiopia, June-September, 2012 (n=3612)

Variables	No.	%
Residence		
Urban	896	24.8
Rural	2716	75.2
Age (Years)		
15-19	179	5.0
20-24	1023	28.3
25-29	1300	36.0
30-34	766	21.2
35-39	311	8.6
40-44	33	0.9
Ethnicity		
Oromo	3161	87.7
Amhara	175	4.8
Dawuro	102	2.8
Others*	174	4.7
Religion		
Muslim	3149	87.1
Orthodox	360	10.0
Protestant	103	2.9
Marital Status		
In marital union	3589	99.4
Not in marital union†	23	0.6
Educational status		
No formal education	1955	54.1
1-4	843	23.3
5-8	479	13.3
9-12	265	7.3
>12	70	1.9
Occupation		
Housewife	3413	94.5
Employed (Gov't, NGO and Private)	88	2.4
Others‡	111	3.1
Husband's Occupation		
Farmer	2566	71.0
Employed (Gov't, NGO and Private)	398	11.1
Merchant	421	11.7
Others‡	227	6.2

**Yem, Kaficho, Guraghe and Tigrie, † Single, divorced and widowed, ‡ Merchant, student, daily labourer*

Table 3: Parameter coefficients and test of goodness-of-fit of the mixed effect multilevel model, Jimma Zone, Southwest Ethiopia, June-September, 2012

Models	Fixed intercept -cons(95%CI)	Random effect as Level-2 variance var(-cons (95%CI))	Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR) (deviance)	Significance of LR test Vs Logistic regression (P-value)
Empty model	0.60(0.38, 0.96)	4.09(2.82, 5.93)	0.554 = 55.4%	-1599.82	<0.0001
Full model	0.03(0.01, 0.06)	1.42(0.94, 2.13)	0.302 = 30.2%	-1447.60	<0.0001

Table 4: Knowledge of key danger signs and birth preparedness and complication readiness practice among respondents, Jimma Zone, Southwest Ethiopia, June-September, 2012.

Variables	**Number (n=3612)**	**Unweighted %**	**Weighted %**
Knowledge of key danger signs			
know all the three key danger signs during pregnancy	227	6.3	6.4
know all the four key danger signs during labour and childbirth	132	3.7	3.6
know all the three key danger signs during postpartum period	88	2.4	2.0
know all the four key danger signs of neonates	75	2.1	2.0
Attitude towards BP and CR (composite)			
Favourable	2202	61.0	62.2
Unfavourable	1410	39.0	37.8
Components of BP and CR practice			
Planed to save money	2656	73.5	69.1
Planed to arrange transport system	2174	60.2	56.1
Planed to give birth in Health facility	1169	32.4	17.9
Planed to be attended by skilled attendant	791	21.9	14.5
Planed to arrange blood donor	719	19.9	17.5
Number of steps taken			
< 3 (Poor preparation)	2367	65.5	76.7
≥ 3 (Good preparation)	1245	34.5	23.3

Table 5: Multilevel analysis of factors associated with birth preparedness and complication readiness, among respondents, Jimma Zone, Southwest Ethiopia, June-September, 2012.

Factors	BP and CR Practice			Crude OR(95%CI)	Adjusted OR(95%CI)
	Prepared (n=1245) n(%)	Not prepared (n=2367) n(%)	Total (n=3612) n(%)		
Higher level variables					
Place of residence					
Rural	580(21.4)	2136(78.6)	2716(100.0)	1.00	1.00
Urban	665(74.2)	231(25.8)	896(100.0)	10.60 (8.90, 12.64)	6.01(2.56, 14.08)
Average distance from health centre (on foot)					
≤2 hours	1108(42.9)	1472(57.1)	2580(100.0)	4.92(4.04, 5.98)	2.93(1.43, 6.02)
>2 hours	137(13.3)	895(86.7)	1032(100.0)	1.00	1.00
Average distance from Hospital (on foot)					
≤2 hours	359(71.4)	144(28.6)	503(100.0)	6.25(5.08, 7.71)	0.95(0.37, 2.44)
>2 hours	886(28.5)	2223(71.5)	3109(100.0)	1.00	1.00
Level-1 variables					
Socio-demographic and economic characteristics					
Age (in years)					
<20	76(42.5)	103(57.5)	179(100.0)	1.00	1.00
20-29	848(36.5)	1475(63.5)	2323(100.0)	0.78(0.57, 1.06)	1.02(0.64, 1.62)
≥30	321(28.9)	789(71.1)	1110(100.0)	0.55(0.40, 0.76)	1.96(0.69, 1.96)
Ethnicity					
Oromo	956(30.2)	2205(69.8)	3161(100.0)	1.00	1.00
Others	289(64.1)	162(35.9)	451(100.0)	4.12(3.35, 5.06)	0.99(0.66, 1.50)
Religion					
Muslim	933(29.6)	2216(70.4)	3149(100.0)	1.00	1.00
Others	312(67.4)	151(32.6)	463(100.0)	4.91(3.98, 6.05)	1.25(0.82, 1.91)
Educational status					
No Formal Education	438(22.4)	1517(77.6)	1955(100.0)	1.00	1.00
Primary (1-8)	541(40.9)	781(59.1)	1322(100.0)	2.40(2.06, 2.80)	1.55(1.24, 1.94)
Secondary (9-12)	201(75.8)	64(24.2)	265(100.0)	10.88(8.05, 14.69)	3.13(2.00, 4.91)
Tertiary (12^{+})	65(92.9)	5(7.1)	70(100.0)	45.03(18.02, 112.51)	8.04(2.14, 30.24)
Occupation					
House wife	1097(32.1)	2316(67.9)	3413(100.0)	1.00	1.00
Employed	74(84.1)	14(15.9)	88(100.0)	11.16(10.28, 19.85)	0.79(0.32, 2.08)
Others	74(66.7)	37(33.3)	111(100.0)	4.22(2.83, 6.31)	0.81(0.45, 1.46)
Occupation of Husband					
Farmer	538(21.0)	2028(79.0)	2566(100.0)	1.00	1.00
Employed	306(76.9)	92(23.1)	398(100.0)	12.54(9.75, 16.13)	1.77(1.14, 2.74)
Merchant	281(66.7)	140(33.3)	421(100.0)	7.57(6.05, 9.47)	2.04(1.40, 2.96)
Others	120(52.9)	107(47.1)	227(100.0)	4.23(3.20, 5.58)	1.15(0.71, 1.85)
Wealth Index					
1^{st} Quintile (lowest)	157(21.7)	565(78.3)	722(100.0)	1.00	1.00
2^{nd} Quintile	249(34.4)	474(65.6)	723(100.0)	1.89(1.50, 2.41)	1.23(0.90, 1.68)
3^{rd} Quintile	250(3.6)	472(65.4)	722(100.0)	1.91(1.51, 2.41)	1.46(1.06, 2.00)
4^{th} Quintile	255(35.3)	468(64.7)	723(100.0)	1.96(1.55, 2.48)	1.24(1.06, 1.72)
5^{th} Quintile (highest)	334(46.3)	388(53.7)	722(100.0)	3.10(2.46, 3.90)	1.56(1.12, 2.19)

Table 5: Multilevel analysis continued…

Obstetric related variables					
Knowledge of key danger signs during pregnancy					
Not knowledgeable	1139(33.6)	2246(66.4)	3385(100.0)	1.00	1.00
Knowledgeable	106(46.7)	121(53.3)	227(100.0)	1.73 (1.32, 2.26)	1.24(0.83, 1.84)
Knowledge of key danger signs during labour and delivery					
Not knowledgeable	1169(33.6)	2311(66.4)	3480(100.0)	1.00	1.00
Knowledgeable	76(57.6)	56(42.4)	132(100.0)	2.68(1.89, 3.82)	2.04(1.22, 3.39)
Knowledge of key danger signs during post natal period					
Not knowledgeable	1198(34.0)	2326(66.0)	3524(100.0)	1.00	1.00
Knowledgeable	47(53.4)	64(46.6)	88(100.0)	2.23(1.46, 3.40)	1.67(0.89, 3.12)
Knowledge of key danger signs of neonates					
Not knowledgeable	1200(33.9)	2337(66.1)	3537(100.0)	1.00	1.00
Knowledgeable	45(60.0)	30(40.0)	75(100.0)	2.91(1.83, 4.66)	1.10(0.60, 2.04)
Attitude toward BP and CR					
Unfavourable attitude	337(23.9)	1073(76.1)	1410(100.0)	1.00	1.00
Favourable attitude	908(41.2)	1294(58.8)	2202(100.0)	2.23(1.93, 2.60)	1.73(1.37, 2.18)
Gravida					
Primi	375(47.8)	410(52.2)	785(100.0)	1.00	1.00
2-4	664(35.0)	1234(65.0)	1898(100.0)	0.58(0.50, 0.70)	0.88(0.67, 1.16)
>4	206(22.2)	723(77.8)	929(100.0)	0.31(0.25, 0.38)	0.72(0.51, 1.03)
ANC Visit					
Not at all	182(15.4)	996(84.6)	1178(100.0)	1.00	1.00
1-3 times	870(41.4)	1229(58.6)	2099(100.0)	3.87(3.24, 4.64)	2.12(1.67, 2.69)
≥4 times	193(57.6)	142(42.4)	335(100.0)	7.44(5.69, 9.73)	2.87(1.98, 4.18)

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The effect of birth preparedness and complication readiness on skilled care use: a prospective follow-up study in Southwest Ethiopia

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Abstracts

Background: Skilled care during and immediately after delivery has been identified as one of the key strategies in reducing maternal mortality. However, recent estimates show that the status of skilled care during delivery remained very low in Ethiopia. Birth preparedness and complication readiness has been implemented as comprehensive strategy to fill this gap. However, its effectiveness in improving skilled care use hasn't been well studied.

Objective: The objective of this study was to determine the effect of birth preparedness and complication readiness on skilled care use in Southwest Ethiopia.

Methods: A prospective follow-up study was conducted from September 2012-April 2013 in Southwest Ethiopia among randomly selected 3472 mothers. Data were collected by using pre-tested interviewer administered questionnaires and analyzed by using SPSS for windows V.20.0 and STATA 13. Mixed-effects multilevel logistic regression model was used to look at the relation between birth preparedness and complication readiness plan and skilled care use and identify other determinant factors.

Results: The status of skilled care use was 17.5% (95% CI: 16.2%, 18.8%). Factors affecting skilled care use existed both at the community as well as individual levels. Planning to use skilled care during pregnancy was found to increase actual use significantly (OR = 2.24; 95%CI: 1.60, 3.15). Place of residence, access to basic emergency obstetric care, maternal education, husband's occupation, wealth quintiles, number of pregnancy, inter-birth interval, knowledge of key danger signs during labor and ANC use were identified as factors affecting skilled care use.

Conclusions: The status of skilled care use was found to be low in the study area. Birth preparedness and complication readiness had significant effect on skilled care use. Socio-demographic, economic, access to health facility, maternal obstetric factors and antenatal care were identified as determinant factors for skilled care use. Designing appropriate interventions to improve information, education and communication, antenatal care use, family planning and knowledge of key danger signs are recommended.

Keywords: Birth preparedness, Complication readiness, Skilled care, Southwest Ethiopia

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Introduction

The fifth Millennium Development Goal (MDG_5) calls for the reduction of Maternal Mortality Ratio (MMR) by 75% between 1990 and 2015. However, only 47% decline had been achieved till 2011 globally [1]. As a result, about 287,000 mothers die because of problems related to pregnancy and child birth each year. About 99% of this occurs in developing countries. Sub-Saharan Africa and Southern Asia account for 85% [2]. This high maternal mortality in developing countries has been largely attributed to the low coverage of skilled care use during delivery [3]. Skilled care during and immediately after delivery and emergency obstetric care have also been identified as key strategies and one of the indicators to track the MDG in reducing maternal mortality. However, recent estimates show that the proportion of deliveries attended by skilled attendant in many African countries remained below 50% [4,5].

Ethiopia is also among the countries committed to achieve the MDG_5 target by reducing maternal mortality by three-quarter. However, the decline in the last 15 years was found to be non-significant with MMR of 676 per 100,000 live-births in the Ethiopian Demographic and Health Survey (EDHS) of 2011 as compared to 673 and 871 per 100,000 live-births in EDHS 2005 and EDHS 2000 respectively. This in turn is also explained by the low coverage of skilled care during delivery in the country. The proportion of births attended by skilled attendant in the country had long been below 5% and hardly reached 10% in 2011 [6-8].

Birth preparedness and complication readiness (BP & CR) has been suggested by the World Health Organization (WHO) as a comprehensive approach for increasing coverage of skilled delivery care and reducing the three delays to care seeking during obstetric emergencies. Many countries in Sub-Saharan Africa including Ethiopia have adopted this approach and included in the routine focused antenatal care. However, its effectiveness has not been well studied [9,10]. Even, the existing studies show conflicting and non-conclusive findings. In a cross-sectional study conducted in India, BP & CR had significant effect on skilled care use [11]. In the contrary, in a field trial study conducted in Nepal, it had non-significant effect [12].

Therefore, for policy and program improvement, it is important to have up-to-date information on the status of BP & CR and its actual effect on skilled care use in different local contexts. Moreover, it is crucial to study whether intention really implies action in skilled care use during delivery. However, though we have few cross-sectional studies on the status, studies on the effectiveness of this approach in increasing skilled care during delivery by strong analytic designs are limited in Africa and non-existent in Ethiopia.

Thus, the purpose of this study was to fill this gap by determining the effect of BP & CR on skilled care use by conducting community based prospective follow-up study in Southwest Ethiopia. The findings of the study will also be used by policy makers and program implementers so as to improve the coverage of skilled care during delivery and achieve the stated MDG target in reducing maternal mortality.

Methods

Study design and setting

This community based prospective follow-up study was conducted in Jimma Zone, located 346kms Southwest of Addis Ababa, the capital city of Ethiopia, from September 2012-April 2013. Jimma Zone is one of the 17 Zones of the Oromia Regional State of Ethiopia, which was named for the former Kingdom of Jimma and absorbed into the former province of Kaffa in 1932. The Zone has a total of 17 rural districts called 'Woredas' and two town administrations with an estimated total population of about 2.6 million and a male-to-female ratio of 1.01:1. The great majority (89%) of the population of the Zone were rural residents. The Zone has a total of 521,506 households with an average household size of 4.77 persons per a household. The potential health service coverage of the zone for the year 2011 was about 52% [13,14].

Source population and study participants

The source or target population considered for this study was all women who had given birth during the study period, from September 2012-April 2013 in Jimma Zone. However, as this was a prospective follow-up study, the study participants were all pregnant women identified based on the sampling procedure and enrolled in the study at a base line and had been followed till 28 days post-partum period. At the baseline, the status of BP & CR and affecting factors were studied which is under review for publication on Pan African Medical Journal. This study was the intermediate one collected during the second phase just at the end of neonatal period. The final study, determinants and causes of neonatal mortality, is again on peer review process for publication on Plos One.

Sample size and sampling technique

The minimum required sample size for this study was determined by using Epi-Info V.3.5.1. by considering two sample comparisons of proportions based on the following assumptions. The outcome variable was skilled care use and the explanatory variable was BP & CR plan. As there was no similar study conducted in the country to be used as a base to determine the sample size, study from other developing country was used. In a study done in India, BP & CR was found to increase the skilled care use by 80% [11].

In Ethiopia, the proportion of women attended by skilled delivery attendant was 10% and this was taken as the proportion among non-exposed group ($P_1 = 0.1$) [8]. The proportion of women attended by skilled attendant among exposed (prepared for birth and its complication) was estimated to be 18% ($P_2 = 0.18$) to detect 8% difference or 80% increment. A level of confidence of 95% and power of 90% were considered. In addition, the coverage of exposure from the general population was estimated to be 22% [15]. Thus, a ratio of 1:4 ($r = 4$) was used for exposed-to-non-exposed. A design effect of 2 was also considered because of the multistage clustered sampling techniques. Finally, 10% was added for non responses and miss to follow-up and the final sample size became 2603 mothers. However, this study was part of a big longitudinal study in which 3612 pregnant women had been on follow-up to look at the determinants of neonatal mortality. As a result, after excluding lost-to-follow-up and abortion cases, 3472 mothers were included in the analysis of this study.

Multi-stage clustered sampling technique was used to identify pregnant women for the study. Initially, the Zone was stratified as Town Administrations (2 in number) and rural districts (17 in number). Then, at first stage, 5 districts were selected randomly from the 17 rural districts ('Woredas'). At second stage, all the selected 5 districts were stratified in to urban and rural 'Kebeles' (A 'kebele' is the smallest administrative unit having 5000 population in average and considered as clusters in this study). Then, by simple random sampling method, 9 rural 'Kebeles' and 2 urban 'Kebeles' were selected from each selected district. Jimma town administration and Agaro town administration have 13 and 5 'Kebeles' respectively and all were included purposefully. Then, for all the selected 'kebeles', pregnant women were enumerated by using house-to-house visit and all obtained and registered were included in the study. All women who reported to have pregnancy of 12 weeks or above as defined by loss of three consecutive menses were considered as eligible and enrolled in the study.

Data collection process

Pre-tested interviewer administered structured questionnaire was adapted from the safe motherhood questionnaire developed by maternal and neonatal health program of JHPIEGO to measure the composite variable for birth preparedness and complication readiness [9]. The indicators for the wealth index were adapted from EDHS [8]. To control the quality of data, training, pretest, supervision and use of local languages were made.

Data management and analysis

The collected data were coded and entered into EpiData V.3.1 to minimize logical errors and design skipping patterns. Then, the data were exported to SPSS for windows version 20.0 for cleaning, editing and analysis. Descriptive analysis was made by computing proportions and summary statistics. Socio-economic quintiles were determined by using Principal Component Analysis (PCA). As Jimma and Agaro town administrations were both purposefully included, the status of skilled care use was estimated by calculating weighted percentage based on the complex sample survey procedure.

Bivariate analysis was done by using cross-tabulation to see associations between each independent variable and skilled care use. All variables having $P < 0.25$ were considered as candidates for the final model. As multistage clustered sampling method was used because of the different levels of factors, mixed-effects multilevel logistic regression model was used by using STATA 13 to identify factors having significant association with skilled care use. 'Kebeles' were considered as clusters and kebele level variables such as place of residence and access to basic emergency obstetric care (BEmOC) and comprehensive emergency obstetric care (CEmOC) were taken as higher level (level-2). Mothers were nested within their households and the community. As a result, maternal individual variables including socio-demographic, economic, obstetric and BP & CR were taken as lower level (level-1). Goodness of fit of the multilevel model was tested by the log likelihood ratio (LR) test. Multicollinearity between the independent variables was assessed by using variance inflation factor (VIF). As all included variables had $VIF < 10$, no multicollinearity was detected. In addition cross-level two-way interactions were checked; but, no significant interaction was detected.

Ethical clearance

Ethical approval was obtained from the Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University. Necessary permission was secured from all local administrators. Written informed consent was obtained from each respondent before actual data collection. Issues of confidentiality were maintained by removing any identifiers from the questionnaire. To protect vulnerable group, data collectors were trained to maintain confidentiality and provide necessary health information based on the need of the participants, but not an intervention.

Operational definition

Birth preparedness and complication readiness

A package of interventions measured as a composite variable of 5 items: planed to save money, planed to arrange transport, planed to give birth in health facility, planed to be attended by skilled attendant and planed to arrange blood donor. Mothers who fulfilled three or

more of the five items were considered as 'well prepared' and otherwise 'not well prepared'.

Identified blood donor

The blood donation system in Ethiopia is based on both volunteer donors and replacement based. In this study, women who had identified volunteer family member to donate the blood during delivery if needed were considered as arranged blood donor and otherwise not.

Skilled care

Delivery attended in health facilities (hospital, health center or private clinics) attended by skilled attendants (doctor, midwife, nurse, health officer or unspecified health worker who has a training of Diploma or above). Delivery attended at health post by HEW was not considered as skilled care.

Results

Socio-demographic characteristics

A total of 3472 respondents were included in the analysis for this study. Majority, 2618 (75.4%), were rural residents. Most, 2227 (64.2%), were in the age group of 20-29 years with the mean age of 26.5 ± 5.0. Oromo was the dominant ethnic group, 3041 (87.6%) and Muslim was the leading religion, 3032 (87.3%). The great majority, 3289 (94.8%), were housewives by occupation and more than half, 1878 (54.1%), didn't attend any formal education (Table 1).

Table 1 Socio-demographic characteristics of respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3472)

Variables	No.	%
Residence		
Urban	854	24.6
Rural	2618	75.4
Age (Years)		
15-19	174	5.0
20-24	974	28.1
25-29	1253	36.1
30-34	739	21.3
35-39	302	8.6
40-44	30	0.9
Ethnicity		
Oromo	3041	87.6
Amhara	169	4.9
Dawuro	97	2.8
Others*	165	4.7
Religion		
Muslim	3032	87.3
Orthodox	342	9.9
Protestant	98	2.8
Marital Status		
In marital union	3452	99.4
Not in marital union†	20	0.6
Educational status		
No formal education	1878	54.1
1-4	811	23.4
5-8	462	13.3
9-12	255	7.3
>12	66	1.9
Occupation		
Housewife	3289	94.8
Employed (Gov't, NGO & Private)	81	2.3
Others‡	102	2.9
Husband's Occupation		
Farmer	2473	71.2
Employed (Gov't, NGO & Private)	373	10.7
Merchant	412	11.9
Others‡	214	6.2

*Yem, Kaficho, Guraghe & Tigrie, † Single, divorced & widowed, ‡Merchant, student, daily laborer.

Maternal health care use during pregnancy and delivery

Of all the 3472 respondents, 2634 (75.9%) had at least one ANC visit during pregnancy and 1830 (52.7%) had used either from hospital or health center attended by skilled attendant. However, only 1228 (35.4%) had four or more visits and 572 (16.5%) started during first trimester. Of the respondents, 1064 (30.6%) used skilled care during delivery (74.1% in urban and 16.5% in rural). However, the weighted coverage of skilled care use was much lower 17.5% (95% CI: 16.2%, 18.8%). The major reasons for giving birth in hospital or health center were pre-planed (43.5%), need skilled attendant (41.0%), problem during labor (28.9%) and need clean/safe place (15.1%). Whereas, the most common reason for home delivery was lack of transport (31.1%) followed by home delivery is the usual place (24.0%) and more comfortable (23.1%) (Table 2).

Intention vs action in skilled care use

A total of 1858 (53.5%) had planned to have 4 or more ANC visits from skilled attendants. However, only 1228 (35.4%) actually had 4 or more ANC visits. Using 4 or more ANC visit was 46.0% among those who planned to have it as compared to 23.2% among who didn't plan which is statistically significant (COR = 2.82; 95%CI: 2.43, 3.27). Similarly, 1136 (32.7%) had planned to use skilled care during labor and 1064 (30.6%) actually used it. About 61.7% of those who had already planed actually used as compared to only 15.5% of who didn't plan

Table 2 Skilled care use during pregnancy and delivery among respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3472)

Variables	No.	Unweighted %	Weighted %
ANC (at least once)			
Yes	2634	75.9	72.2
No	838	24.1	27.8
Place of ANC (n = 2634)			
Hospital	145	5.5	1.2
Health Centre	1585	60.2	55.5
Private clinic/FGAE	100	3.8	0.7
Health Post	804	30.5	42.6
Attendant of ANC (n = 2634)			
Skilled attendant[5]	1830	69.5	57.4
HEW	804	30.5	42.6
# of ANC visit (n = 2634)			
1-3	1406	53.4	61.7
≥4	1228	46.6	38.3
GA at ANC start (n = 2634)			
1st trimester	572	21.7	16.3
2nd trimester	1771	67.2	72.0
3rd trimester	291	11.0	11.7
Place of delivery			
Hospital	425	12.2	6.4
Health Centre	573	16.5	10.7
Private clinic/FGAE	66	1.9	0.4
Health Post	48	1.4	1.8
Home/TBA's Home	2360	68.0	80.7
Delivery attendant			
Skilled attendants[5]	1064	30.6	17.5
HEW	59	1.7	2.2
Family/TBA	2349	67.7	80.3
Mode of delivery			
SVD	3336	96.1	96.8
C/S	80	2.3	1.5
Assisted	56	1.6	1.7
Reasons for health facility delivery (n = 1112, multiple response)			
Pre-planned	484	43.5	
Need skilled attendant	456	41.0	
Problem during labor	321	28.9	
Need clean/safe place	168	15.1	
Reasons for home delivery (n = 2360, multiple response)			
Lack of transport	735	31.1	
Home delivery is my usual place	567	24.0	
Home delivery is more comfortable	546	23.1	
Lack of money for transport	289	12.2	
Lack of money for service cost	142	6.0	

[5]Doctor, nurse, midwife, HO, unspecified health workers.

which is statically significant (COR = 8.76; 95% CI: 7.44, 10.32).

Four hundred thirty five (38.3%) of those who had already planned to use skilled care didn't use it actually. The main reasons were the labor was not associated with problems 382 (87.8%), lack of transport 64 (14.7%) and lack of money for transport and services 58 (13.3%). On the other hand, 363 (15.5%) of those who didn't plan to use skilled care actually used it. The main reason was occurrence of unanticipated problems at labor 174 (47.9%) among which prolonged labor was the leading one 152 (41.9%). The other reason was family insisted at labor to have safe and clean delivery 99 (27.3%). This indicated that intention significantly implies action in skilled care use; however, not 100% as complication during labor is unpredictable (Table 3).

Factors affecting skilled care use

To evaluate the applicability of the mixed-effects multilevel logistic regression model, the Intra-class Correlation Coefficient (ICC (ρ)) was calculated in the empty model and it was found to be 0.489 indicating that 48.9% of the variation was contributed by between cluster variation. The test of the preference of log likelihood Vs logistic regression was also strongly significant ($P < 0.001$). Then, the full model was run by including all the cluster level and individual level variables and the ICC (ρ) became 0.113 indicating that 11.3% of the variation was attributed to cluster level variables again suggesting the preference of multilevel analysis. The preference of log likelihood Vs logistic regression was still strongly significant ($P < 0.0001$).

After adjusting in the final two-level mixed-effects logistic regression model, both the cluster level variables and individual level variables were found to be important determinants of skilled care use. Among the higher (cluster) level variables, place of residence and access to BEmOC were found to have statistically significant association with skilled care use. Women in urban areas were more than two times more likely to use skilled care as compared to rural women (OR = 2.38; 95%CI: 1.74, 3.24). Similarly,

Table 3 Intention vs action in skilled care use during pregnancy and child birth and reasons among respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3472)

Plan (intention)	Actual practice (Action)			P-value
	Had ≥ 4 ANC Visit			
Planed ≥ 4 ANC Visit	**Yes n(%)**	**No n(%)**	**Total n(%)**	P < 0.001 (COR = 2.82; 95%: 2.43, 3.27)
Yes	854 (46.0)	1004 (54.0)	1858 (53.5)	
No	374 (23.2)	1240 (76.8)	1614 (46.5)	
Total	1228 (35.4)	2244 (64.6)	3472 (100.0)	
Planned to use skilled care during delivery	**Used skilled care during delivery**			P < 0.001 (COR = 8.76; 95%: 7.44, 10.32)
	Yes n(%)	**No n(%)**	**Total n(%)**	
Yes	701 (61.7)	435 (38.3)	1136 (32.7)	
No	363 (15.5)	1973 (84.5)	2336 (67.3)	
Total	1064 (30.6)	2408 (69.4)	3472 (100.0)	
Reasons for not using skilled care once planed (n = 435)			**No.**	**%**
Labor not associated with problems (short and comfortable labor)			382	87.8
Lack of transport			64	14.7
Lack of money			58	13.3
Reasons for using skilled care which was not planed (n = 363)				
Any problem encountered during labor			174	47.9
Prolonged labor (>12 hours)			152	41.9
Family insisted at labor to have safe and clean delivery			99	27.3

women in clusters having BEmOC (health center) within 2 hours distance on foot in average were more likely to use skilled care (OR = 1.61; 95%CI: 1.12, 2.33). However, having CEmOC (hospital) within 2 hours distance on foot in average had non-significant effect on skilled care use (OR = 1.36; 95%CI: 0.74, 2.51).

Among the lower (individual) level variables, maternal education, husband's occupation, wealth quintiles, gravida, inter-birth interval, knowledge of key danger signs during labor, ANC visit and BP & CR were found to have statistically significant association with skilled care use. Having primary (OR = 1.37; 95%CI: 1.10, 1.71), secondary (OR = 3.48; 95%CI: 2.22, 5.45) or tertiary (OR = 3.97; 95%CI: 1.38, 11.46) educations were found to increase the likelihood of skilled care use significantly as compared to not having formal education. Similarly, women whose husbands were employed (OR = 3.26; 95%CI: 2.15, 4.94) or merchants (OR = 2.27; 95%CI: 1.60, 3.23), were more likely to use skilled care as compared to those whose husbands were farmers. Women in the 3rd wealth quintiles (OR = 1.73; 95%CI: 1.12, 1.84) and 4th quintiles (OR = 1.28; 95% CI: 1.11, 1.73) were more likely to use skilled care as compared to those in the lowest quintile.

Gravida and inter-birth interval were among the individual level obstetric factors found to have significant association with skilled care use. Mothers with experience of 1-4 pregnancies (OR = 0.41; 95%CI: 0.26, 0.66) and 5 or more (OR = 0.45; 95%CI: 0.26, 0.76) were less likely to use skilled care as compared to primi-gravida mothers. Inter-birth interval of >48 months was found to increase the likelihood of skilled care use as compared to interval of <24 months (OR = 2.18; 95%CI: 1.30, 3.63).

Knowledge of key danger signs during labor was the other determinant of skilled care use. Women who knew 3 or more key danger signs during labor were more likely to use skilled care as compared to those who didn't know any key danger signs (OR = 1.59; o5%CI: 1.05, 2.43). Similarly, having 1-3 ANC visits (OR = 1.63; 95%CI: 1.23, 2.18) and ≥4 visits (OR = 3.10; 95%CI: 2.31, 4.16) during pregnancy were found to increase the likelihood of skilled care use significantly. After controlling all the necessary variables in the mixed-effects multilevel model, birth preparedness and complication readiness plan had significant effect on skilled care use. Women who were well-prepared during pregnancy were more likely to use skilled care as compared to those who were not well-prepared (OR = 1.32; 95%CI: 1.03, 1.68) (Table 4).

Discussions

The World Health Organization (WHO) strongly recommends that every pregnancy should be delivered under skilled care [16]. The UN's MDG also had set a target of 90% coverage of skilled care by the end of 2015. But, in this study, the status of skilled care use was found to be very low (17.5%) as compared to this target. This is almost comparable with the findings of other previous studies in the country in which the coverage of skilled care uses were

Table 4 Multilevel analysis of factors associated with skilled care use among respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3472)

Factors	Skilled care use			Crude OR (95%CI)	Adjusted OR (95%CI)
	Skilled care (n = 1064) n(%)	Non skilled care (n = 2408) n(%)	Total (n = 3472) n(%)		
Leve-2 (communal) variables					
Place of residence					
Rural	431 (16.5)	2187 (83.5)	2618 (100.0)	1.00	1.00
Urban	633 (74.1)	221 (25.9)	854 (100.0)	14.49 (12.05, 17.54)	2.38 (1.74, 3.24)
Distance from Health center (on foot)					
≤ 2 hours	917 (37.5)	1531 (62.5)	2448 (100.0)	3.57 (2.95, 4.33)	1.61 (1.12, 2.33)
>2 hours	147 (14.4)	877 (85.6)	1024 (100.0)	1.00	1.00
Distance from Hospital (on foot)					
≤ 2 hours	356 (73.7)	127 (26.3)	483 (100.0)	9.03 (7.25, 11.25)	1.36 (0.74, 2.51)
>2 hours	708 (23.7)	2281 (76.3)	2989 (100.0)	1.00	1.00
Leve-1 (individual level) variables-socio-demographic & economic					
Age (in years)					
<20	77 (44.3)	97 (55.7)	174 (100.0)	1.00	1.00
20-29	740 (33.2)	1487 (66.8)	2227 (100.0)	0.63 (0.46, 0.86)	1.32 (0.85, 2.07)
≥30	247 (23.1)	824 (76.9)	1071 (100.0)	0.38 (0.27, 0.53)	1.34 (0.80, 2.23)
Ethnicity					
Oromo	775 (25.5)	2266 (74.5)	3041 (100.0)	1.00	1.00
Others	289 (67.1)	142 (32.9)	431 (100.0)	5.95 (4.79, 7.39)	1.21 (0.80, 1.84)
Religion					
Muslim	754 (24.9)	2278 (75.1)	3032 (100.0)	1.00	1.00
Others	310 (70.5)	130 (29.5)	440 (100.0)	7.20 (5.78, 8.98)	1.33 (0.88, 2.04)
Educational status					
No Formal Education	341 (18.1)	1538 (81.9)	1879 (100.0)	1.00	1.00
Primary (1-8)	454 (35.7)	818 (64.3)	1272 (100.0)	2.50 (2.12, 2.95)	1.37 (1.10, 1.71)
Secondary (9-12)	208 (81.6)	47 (18.4)	255 (100.0)	19.96 (14.24, 27.98)	3.48 (2.22, 5.45)
Tertiary (>12)	61 (92.4)	5 (7.6)	66 (100.0)	55.03 (24.94,137.97)	3.97 (1.38, 11.46)
Occupation					
House wife	928 (28.2)	2361 (71.8)	3289 (100.0)	1.00	1.00
Employed	72 (88.9)	9 (11.1)	81 (100.0)	20.35 (10.14, 40.87)	0.84 (0.30, 2.31)
Others	64 (62.7)	38 (37.3)	102 (100.0)	4.28 (2.85, 6.45)	0.83 (0.48, 1.44)
Occupation of Husband					
Farmer	371 (15.0)	2102 (85.0)	2473 (100.0)	1.00	1.00
Employed	303 (81.2)	70 (18.8)	373 (100.0)	24.39 (18.52, 32.26)	3.26 (2.15, 4.94)
Merchant	267 (64.8)	145 (35.2)	412 (100.0)	10.42 (8.26, 13.16)	2.27 (1.60, 3.23)
Others	123 (57.5)	91 (42.5)	214 (100.0)	7.63 (5.71, 10.31)	1.50 (0.96, 2.32)
Wealth Index					
1st Quintile (lowest)	148 (21.8)	532 (78.2)	680 (100.0)	1.00	1.00
2nd Quintile	233 (33.0)	472 (67.0)	705 (100.0)	1.77 (1.39, 2.56)	1.20 (0.88, 1.64)
3rd Quintile	222 (32.0)	472 (68.0)	694 (100.0)	1.69 (1.32, 2.16)	1.73 (1.12, 1.84)
4th Quintile	217 (31.2)	478 (68.8)	695 (100.0)	1.63 (1.28, 2.08)	1.28 (1.11, 1.73)
5th Quintile (highest)	244 (35.0)	454 (65.0)	698 (100.0)	1.93 (1.52, 2.46)	1.09 (0.80, 1.48)

Table 4 Multilevel analysis of factors associated with skilled care use among respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3472) *(Continued)*

Level-1 (Individual)-obstetric					
Gravida (# of pregnancies)					
Primi (1st)	377 (51.3)	358 (48.7)	735 (100.0)	1.00	1.00
2-4	531 (28.9)	1304 (71.1)	1835 (100.0)	0.39 (0.32, 0.46)	0.41 (0.26, 0.66)
>4	156 (17.3)	746 (82.7)	902 (100.0)	0.20 (0.16, 0.25)	0.45 (0.26, 0.76)
Inter-birth interval					
<24 Months	43 (17.1)	209 (82.9)	252 (100.0)	1.00	1.00
24-48 Months	489 (22.5)	1680 (77.5)	2169 (100.0)	1.42 (1.01, 1.99)	1.27 (0.83, 1.95)
>48 Months	155 (49.1)	161 (50.9)	316 (100.0)	4.68 (3.15, 6.95)	2.18 (1.30, 3.63)
Primi gravid	377 (51.3)	358 (48.7)	735 (100.0)	N/A	N/A
Knowledge of key danger signs during labor & delivery					
Not know at least 1 key danger sign	330 (24.2)	1031 (75.8)	1361 (100.0)	1.00	1.00
Know 1-2 key danger signs	607 (33.7)	1192 (66.3)	1799 (100.0)	1.59 (1.36, 1.86)	1.09 (0.86, 1.39)
Know 3-4 key danger signs	127 (40.7)	185 (59.3)	312 (100.0)	2.15 (1.66, 2.78)	1.59 (1.05, 2.43)
Knowledge of key danger signs of neonates					
Not know at least 1 key danger sign	414 (25.8)	1189 (74.2)	1603 (100.0)	1.00	1.00
Knows 1-2 key danger signs	570 (33.9)	1111 (66.1)	1681 (100.0)	1.47 (1.27, 1.71)	1.07 (0.85, 1.35)
Knows 3-4 key danger signs	80 (42.6)	108 (57.4)	188 (100.0)	2.13 (1.56, 2.90)	1.19 (0.71, 1.98)
No. of ANC Visit					
Not at all	110 (13.1)	728 (86.9)	838 (100.0)	1.00	1.00
1-3 times	321 (22.8)	1085 (77.2)	1406 (100.0)	1.96 (1.55, 2.48)	1.63 (1.23, 2.18)
≥4 times	633 (51.5)	595 (48.5)	1228 (100.0)	7.04 (5.60, 8.86)	3.10 (2.31, 4.16)
BP & CR practice					
Not well prepared	425 (18.7)	1844 (81.3)	2269 (100.0)	1.00	1.00
Well prepared	639 (53.1)	564 (46.9)	1203 (100.0)	4.92 (4.21, 5.74)	1.32 (1.03, 1.68)

N/A Not Applicable.

less than 15% [8,17-20]. However, this finding is lower than the findings of similar studies conducted in other developing African countries in which skilled care use ranged from nearly 40-50% [21-24]. The difference may be due to variations in interventions from country to country. This clearly indicated that a lot needs to be done in the study area as well as in the country to increase the status of skilled care use so as to attain the desired target.

Though intention didn't 100% imply action in skilled care use, delivery planning ahead by identifying place of delivery significantly increased the actual use in this study. The major reason for those who didn't actually translate their intention in to action was that complication during labor was not predictable. Some of those who planned to give birth at home delivered at health facility because of the occurrence of problems and some of those who planned to go to health facility gave birth at home as their labor was short and didn't encounter any problem. This finding is consistent with other prior studies where occurrence of problem during labor is the primary reason for women in developing countries to seek skilled care at birth [20,21].

In this study, both the higher level and lower level variables were found to be important determinants of skilled care use suggesting the importance of interventions both at the community as well as individual levels. Among the higher level variables, place of residence and access to BEmOC were the important determinants of skilled care use. This is consistent with other studies conducted before [17-21]. This may be explained by the fact that women in urban areas have more access to skilled care, access to education and media that might have increased their level of risk perception and thereby increased skilled care use.

Among the individual level variables related to sociodemographic and economic characteristics, maternal education, husband's occupation and wealth quintiles were identified as determinants of skilled care use in this study. These findings are again consistent with other prior studies in the country as well as aboard [17-28]. This may be

because, better education increases access to information, risk perception, employment and income which in turn increase health seeking behavior for obstetric complications.

Among the obstetric factors, number of pregnancies (gravida) and inter-birth interval were found to be important determinants of skilled care use in this study. Number of pregnancies had inverse relationship with the rate of skilled care use. Multi-gravida women were less likely to use skilled care. This is consistent with other studies conducted before [17-20]. This may be due to the existence of less risk and less occurrence of prolonged labor as compared to primi-gravida mothers. On the other hand, inter-birth interval of more than 4 years had significant effect in increasing skilled care use. Many international evidences has also suggested that inter-birth interval of 2 years and above significantly improves maternal and child health including skilled care use [21]. This may be due to the reason that mothers may get free time and rest and prepare themselves when they have enough time between pregnancies and utilize the services.

Knowledge of key danger signs during labor, ANC visit and BP & CR plan were also among the individual level variables found to have statistically significant effect on skilled care use in this study. This is also similar with the findings of other previous studies [17-22,29-31]. This can be explained by the fact that women might have received adequate information about danger signs, birth planning and importance of skilled care during ANC visits that facilitated the actual practice at the time of labor. With this, this study revealed that birth preparedness is effective in enhancing skilled care use during delivery if appropriately implemented.

For policy and program implications, this study came up with the evidence that intention implies action in skilled care use; but sometimes this may not be the case as complication during labor is unpredictable. This pointed out to the importance of raising the knowledge of women on key danger signs, risk perception and enhancing birth planning by every pregnant women and her family so that every delivery will be conducted under skilled care.

This study has its own strengths in that the design was prospective follow-up study that measured fresh memory of the mothers and minimized recall bias. It also used large sample size that resulted in high power for the multilevel analysis. In addition, strong statistical model (mixed-effects multilevel analysis) was used to handle clustering effects. This study may have its own limitations in that it measured access to health facility, but didn't address the quality of the health facility which could have been one of the determinant factors, which may be area for further research. In addition, access to CEmOC had non-significant effect on skilled care use. This might be because, the distance was measured in women's oral approximate report and no instruments like GPS were used to know the exact distance. There might also be some unobserved cluster (community) level factors like road and transport availability that might have affected this relation which needs to be considered in future researches.

Conclusions

This study revealed that the status of skilled care use (17.5%) in the study area is still very low as compared to MDG target. The study also revealed that both community level and individual level factors were important determinants of skilled care use. The study also found that birth preparedness plan has significant effect in enhancing skilled care use during delivery. Place of residence, access to BEmOC, maternal education, husband's occupation, wealth quintiles, number of pregnancy, inter-birth interval, knowledge of key danger signs during labor and ANC use were identified as factors affecting skilled care use. IEC/BCC to increase ANC use, enhancing BP & CR plan with particular emphasis to key danger signs and improving family planning use for birth spacing are recommended as short term interventions. As a long term interventions, female education and improving access to BEmOC with midwifery skills are recommended.

Abbreviations

ANC: Antenatal Care; BP: Birth Preparedness; CR: Complication Readiness; HEW: Health Extension Worker; OR: Odds Ratio; COR: Crude Odds Ratio; SVD: Spontaneous Vaginal Delivery.

Competing interests

The authors declare that they do not have any competing interest concerning the findings of the study.

Authors' contributions

GTD involved in the conception of the study. GTD, MFA and AWY involved in the design, data collection process, analysis and interpretations of the findings. GTD prepared the initial manuscript which latter be read and edited by MFA and AWY. The final manuscript was read and approved by all authors.

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Annex 1.4. Tura G, Fantahun M, Worku A. Neonatal care practice and affecting factors in Southwest Ethiopia: a multilevel linear regression analysis. **(Under review, *BMC International Health and Human Rights).***

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Abstract

Background: A significant proportion of neonatal mortality can be prevented by the provision of the minimum neonatal care package. However, about 3 million neonates die each year globally because of lack of appropriate care. This situation is the worst in Ethiopia. Thus, investigating the status of neonatal care practice and affecting factors in the local context are very relevant for designing alternative strategies.

Methods: A prospective follow-up study involving both quantitative and qualitative methods was conducted from September 2012-December 2013 in Southwest Ethiopia. Randomly selected sample of 3463 mothers were interviewed to collect the quantitative data. Twelve in-depth interviews with purposively selected key informants and six focus-group discussions with purposively selected mothers were conducted for the qualitative data. Mixed-effects multilevel linear regression model was used to identify predictors of neonatal care practice by using STATA 13. Audio recording, transcription and thematic analysis was done for the qualitative data.

Results: The overall status of neonatal care practice was 59.5% (95%CI: 57.6%, 61.3%). Of the respondents, 53.8% received tetanus toxoid, 23.8% planed for birth, 41.9% received at least one antenatal care and 43.0% received adequate information during pregnancy. Only, 17.5% received skilled care at birth and 95.0% received social support. Of the neonates, 96.5% received appropriate thermal care, 86.5% received clean cord care, 64.1% initiated breast-feeding within one hour, 91.5% were on exclusive breast-feeding, 56.5% received appropriate bathing and 8.1% received vaccination on date of birth. Place of residence, maternal education, husband‘s occupation, wealth quintiles, birth order and inter-birth interval were identified as predictors of neonatal care practice.

Conclusions: Though the overall status of neonatal care practice was good, there were variations in coverage of the components of neonatal care practice. Giving birth in health facility attended by skilled attendants and receiving vaccination on date of birth were the worst practices. Predictors of neonatal care existed both at cluster level and at the individual level and included socio demographic, economic and obstetric factors. Appropriate birth spacing, birth limiting and behavior change communications on the importance of neonatal care are recommended.

Keywords: *Neonatal care practice, factors affecting neonatal care, Southwest Ethiopia, multilevel linear regression*

Introduction

Worldwide, about 3 million neonates die each year because of lack of appropriate care [1]. The biggest burden (98%) of this neonatal death is shouldered by the low and middle-income countries. Sub-Saharan Africa is among the regions showing the least progress in reducing neonatal mortality [1]. Most of these deaths are caused by infectious diseases, pregnancy-related complications and delivery-related complications, including intra-partum asphyxia, birth-trauma and premature birth, all of which can easily be prevented by providing the appropriate package of neonatal care [2, 3].

The global health actors, including researchers, policy makers and program implementers have been searching for new knowledge and technologies for child survival for many years. However, the issue of neonatal survival remained unfinished agenda and is among the unachieved millennium development goal targets identified for the post-2015 priorities [4, 5].

Ethiopia is among the low-income countries with the highest rate of neonatal mortality (37 deaths per 1000 live births) and showing very slow progress. Though the country is among the fast progressing countries in reducing under-five mortality and achieving the millennium development goal 4 (MDG_4), the challenge of neonatal mortality is still a quandary [6-9].

Evidences suggest that a significant proportion of this neonatal mortality can be prevented by inexpensive, simple practices and interventions along the continuum of care starting from pre-pregnancy, during pregnancy, delivery and postnatal period [6-8, 10-12]. As part of neonatal survival strategies, The Lancet Neonatal Survival Steering Team identified evidence-based cost-effective interventions and published in 2005 [13]. Following this, the World Health Organization (WHO) developed a minimum neonatal care package to be given during pregnancy, labor and childbirth, the immediate postpartum period and the first 28 days of life [14]. This minimum neonatal care package includes tetanus toxoid (TT) immunization,b irth preparedness and complication readiness (BPCR), antenatal care (ANC) visit and adequate information on neonatal care during pregnancy; skilled care and social support during labor and delivery and immediate thermal care, clean and safe cord care, timely and exclusive breast feeding, appropriate bathing time and immunization on date of birth during the post partum period (15).

Almost all countries, including Ethiopia, have adopted this strategy and have been implementing for nearly a decade. However, newborn care often receives less-than-optimum attention. Besides, newborn care is strongly influenced by women‘s social and health status and by home care practices for mother and newborn as well as by maternal and newborn care services. Traditional care practices during delivery and immediately for newborn at home and in the community inevitably affect the health of the neonates. However, the major challenge is lack of adequate data about the local practices at the community level for program improvement [15-18].

Thus, it is crucial to have up-to-date information on the existing neonatal care practices and affecting factors to design more successful interventions. To the investigators‘ knowledge, the status of provision of the minimum neonatal care package and affecting factors have not been well assessed in the study area. Therefore, there is a need for research to identify the factors at the community as well as at the individual levels for more effective and efficient programming. Thus, the purpose of this study was to fill these gaps by conducting a community-based prospective follow up study in Southwest Ethiopia. The findings of the study will have paramount importance for policy makers and program implementers in designing comprehensive strategies and alternative neonatal survival interventions.

Methods

Study design and setting

This community-based prospective follow up study, employing both quantitative and qualitative data collection methods, was conducted in Jimma Zone, Southwest Ethiopia from September 2012 to December 2013. Jimma Zone is one of the 17 Zones of the Oromia Regional State of Ethiopia. Administratively, the Zone is sub-divided in to 17 rural districts called ‗*Woredas*' and two town administrations. According to the 2007 national population and housing census, the Zone has a total population of about 2.6 million, of whom 88.7% are rural residents [19, 20].

Population, sample size and sampling methods

Mothers who had given birth 28 days before the survey were the study populations for the quantitative method. The minimum required sample size for this study was determined by using Epi-Info V.3.5.1 based on the following assumptions. The status of neonatal care practice as determined by the mean score of composite variable (indices) was assumed to be 29% (p=0.29) [21]. The allowed margin of error to be 3% (d=0.03) with 95% level of confidence. In addition, as multistage-clustered sampling method was used, a design effect of 2 was considered. Finally, 10% was added for non-responses and missed-to-follow up and the final sample size became 1934 mothers. This study was part of a bigger longitudinal study in which 3463 mothers were followed up. Therefore, to increase the precision of the estimates and power of the study, we included all the 3463 mothers in this study.

A multistage-clustered sampling technique was used to identify the study participants. Initially, the Zone was stratified as town administration and rural districts called '*Woredas*'. Then, 5 districts were selected by simple random sampling from the 17 districts. At second stage, 9 rural ‗*Kebeles*' and 2 urban ‗*Kebeles*' were selected from each selected district randomly. Jimma town administration and Agaro town administration have 13 and 5 '*kebeles'*, respectively and all were included purposefully. With this, in total, 73 clusters (*'Kebeles'*) were included in the study from which 3682 pregnant women were enumerated and enrolled to the study at the baseline. All the enrolled pregnant women were followed till 28 days postpartum period and neonatal care practice was assessed at the end of neonatal period.

To have in-depth understanding of neonatal care practices and contributing factors, 12 in-depth interviews (IDIs) and 6 Focus Group Discussions (FGDs) were conducted. The IDIs involved 4 service providers, 4 traditional birth attendants (TBAs) and 4 Health Extension Workers (HEWs) all of whom were selected purposively based on their close relation with mothers and neonates and assumed to be rich sources of information on the topic of the study. The FGDs involved purposively selected 8-10 mothers having post neonatal infants (1-6 months) each. The number of IDIs and FGDs were determined based on level of saturation of the required information.

Instruments and measurements

The data were collected by using pre-tested interviewer-administered structured questionnaires, which were adapted from related literatures. The indicators for the wealth index were adapted from Ethiopian Demographic and Health Survey (EDHS) [8]. Indicators for neonatal care practice were adapted from the World Health Organization (WHO) minimum neonatal care package [14]. The questionnaire was prepared in English, then translated to local languages ‗Afan Oromoo' and Amharic and used to collect the data.

The dependent variable for this study was neonatal care practice, which was a composite score (index) created from 12 items and treated as continues variable. By taking ‗*Kebeles*' as clusters, the independent variables were divided into two levels. Level-2 (higher level variables) included community or cluster-level variables such as place of residence, access to health centres and access to hospitals. Level-1 (lower-level variables) included individual and household characteristics such as: socio-demography, wealth quintiles and maternal obstetric factors. The detail description of each variable is given below (Table 1).

Data management and analysis

The collected data were coded and entered into Epidata V.3.1 to minimize logical errors and design skipping patterns. Then, the data were exported to SPSS for windows version 20.0 for cleaning, editing and analysis. Descriptive analysis was done by computing proportions and summary statistics. Wealth quintiles were determined by using Principal Component Analysis (PCA). Similarly, neonatal care practice, a continues dependent variable, was created as a composite index (score) by using PCA.

The index was created by including the 12 elements of the minimum neonatal care package described in table 1 above. While doing the PCA, colinearities between the independent variables were checked by producing correlation matrix. However, no correlation coefficient was 0.9 or above for a variable to be excluded. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.74. (>0.50 is acceptable) and Bartlett's Test of Sphericity was significant ($P < 0.001$). The importance of each variable for the model was checked by looking at the communalities and those variables having communalities < 0.5 were removed one by one from the model until all have ≥ 0.5. The eigenvalues was set to include values over 1.

Based on this, receiving social support during labor, receiving vaccination on date of birth and BPCR were excluded. As a result, 10 variables remained in the final model creating 4 principal components with eigenvalues > 1.0 explaining 65.04% of the total variance (>60% is acceptable to use PCA). No variable was found to have complex structure or high loadings (> 0.4 in more than one component in the rotated component matrix). Inter-item consistencies for the variables making each component were checked by Cronbach's alpha and all were > 0.7. The existence of outliers were checked by sorting each principal component by ascending order and all cases were within the range of ±3 factor scores. Finally, all the 4 components were added and an index (score), the continues dependent variable, was created.

The status of neonatal care practice was determined by dichotomizing the score based on the mean value of the score. As Jimma town administration and Agaro town administration were included purposefully, weighted analysis was done to avoid urban over representation and over estimation of the status of neonatal care practices. The weighted analysis was done based on the complex-sample survey procedure by considering the probability of exclusion at different stages and the non-responses.

To identify factors affecting neonatal care practice, first, bivariate analysis was done to see associations between each independent variable and neonatal care practice. Then, all variables having $P < 0.25$ were considered as candidates for the multivariable model.

Because of the different levels of factors, a mixed-effects multilevel linear regression model was used by using STATA 13 to identify factors having significant associations with neonatal care practice. This model was preferred in order to avoid the clustering

effects that violets the assumption of independence among the study subjects. To evaluate the existence of sufficient variance at the cluster level in influencing neonatal care practice, intercept-only model was fitted and Interclass Correlation Coefficient (ICC) was determined. Besides, goodness-of-fit of the multilevel model was tested by the log likelihood ratio (LR) test. Multicollinearity between the independent variables was assessed by using variance inflation factors (VIF >10 were considered as suggestive of existence of multicollinearity). In addition, cross-level two-way interactions were checked. Beta (β)-coefficients along with 95%CI were used to show the strength of the associations and level of significance.

The audio taped qualitative data were transcribed in to English language. Then, codes or terms were identified and tallied to come up with some categories, which later used to establish themes based on the objective of the study. Finally, thematic analyses was done and the findings were triangulated with the quantitative one.

Ethical consideration

Ethical approval was obtained from the Institutional Review Board (IRB) of the College of Health Sciences of Addis Ababa University. In addition, written informed consent was obtained from each respondent before actual data collection.

Results

Socio-demographic characteristics

From the total of 3682 pregnant women enumerated and interviewed at the initial stage, 3612 pregnant women were included in the analysis at the baseline and enrolled to the follow up study after excluding 70 incomplete questionnaires. After excluding incomplete questionnaires, abortion cases, missed-to-follow up, maternal deaths and stillbirths, a total of 3463 live births happened and included in the analysis of this study making a response rate of 95.9%. Of the total 3463 respondents, 75.1% were from urban residence. Majority (63.8%) of the mothers were in the age group of 20-29 years. Oromoo was the dominant ethnic group (87.6%) and Muslim was the leading religion (87.2%). More than half (54.0%), have not attended any formal education (Table 2).

Neonatal care practices

Among the components of neonatal care practices during pregnancy, 53.8%, 23.8%, 41.9% and 43.0% received TT, planed for birth, received ANC and received adequate information on neonatal care, respectively. Among the elements of neonatal care during labor and delivery, 17.5% and 95.0% received skilled care and social support during labour, respectively.

Among the components after birth, 96.5% received immediate thermal care, 64.1% started breastfeeding within one hour of birth, 86.5% got clean cord care, 91.5% on exclusive breast-feeding, 56.5% got bathing at appropriate time (after 6 hours of birth) and 8.1% received vaccination (BCG and Polio-0) on the date of birth. By using these parameters, composite index was produced by using PCA and mean score was determined. Accordingly, 59.5% (95%CI: 57.6%, 61.3%) of neonates scored above or equal to the mean score and labeled as received good neonatal care (Table 3).

The qualitative finding was also supplemented the quantitative one in that still there are problems in the coverage of some of the neonatal cares. The qualitative part particularly focused on breastfeeding, thermal care, cord are and neonatal immunization. According to the opinions of most of the respondents, previously there were problems in newborn feeding practices that most mothers do not start breast-feeding immediately. They also

used to give fresh butter to the newborn to swallow with the assumption that he/she will not cry during the childhood. Now a days, the HEWs are educating the mothers and every mother gives breastfeeding immediately.

Concerning thermal care, mixed practices were reported by majority of the respondents. As repeatedly mentioned, during home delivery, almost all newborns are wrapped with clean new towel and put in front of mothers or someone caries them carefully. However, almost all mothers and newborns are washed just immediately or within thirty minutes by cold water. This is because of lack of knowledge about the importance of delayed bathing.

A 28 years old FGD discussant said, *"I gave birth to my child two months back by the help of traditional birth attendant. Just immediately, as the placenta was out, she washed me and my newborn with cold water. As to me, this is what all women in our community practice...."*

A key informant TBA added, *"...Both the mother and the newborn are contaminated with dirty blood. How can they stay with it for long hours? That is why we encourage immediate wash of both the mother and the newborn...."*

Concerning cord care, majority of the respondents had the view that previously, the mothers reuse rather blades to cut umbilical cord and put butter on umbilical stamp. But now, every woman knows its drawback and no such practices. Regarding to immunization, as reported by the majority, vaccination is the major problem of neonatal care. As most reported, previously mothers had no adequate knowledge and do not accept child immunizations. But now, every woman knows its benefits. However, the neonates are not getting appropriately because of many reasons from service providers. The major reported problems were unavailability of vaccines and when available, the providers do not open for few neonates.

A 24 years old FGD discussant stated, *"...I had taken my neonate two times to the health centre, but he never received the vaccine. On first day, the provider said, 'I can't open the vaccine for less than 10 children' and appointed me for a week. Again after a week, he said, 'no vaccine at all! Come another day!' I never went there again..."*

A HEW added, *"...we have been facing problems of open vial policy. We are not supposed to open BCG vial unless there are 10 neonates. We used to appoint mothers to bring on same day to open. But, they do not come on same day at same time. As a result, many neonates are not getting the BCG vaccine...."*

Factors affecting neonatal care practice

To evaluate the applicability of the mixed-effects multilevel linear regression model, the ICC (ρ) was calculated in the empty-model and it was found to be 0.332 indicating that 33.2% of the variation was contributed by between cluster variation. The test of the preference of log likelihood versus linear regression was also strongly significant ($P<0.0001$). Then, the final full model was run by including all the cluster level and individual level variables and the ICC (ρ) became 0.157. This again indicated that 15.7% of the variation was attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood versus linear regression was again strongly significant ($P<0.0001$) (Table 4).

After adjusting in the final two-level mixed-effects linear regression model, predictors of neonatal care practice existed both at the cluster level as well as at the individual

level. Among the higher (cluster) level variables, place of residence was found to have statistically significant association with neonatal care practice. Being in urban residence was found to increase the neonatal care practice significantly (β =0.86; 95%CI: 0.45, 1.23).

Among the lower level (individual) variables, maternal education, husband‘s occupation, wealth quintiles, birth order and inter-birth interval were identified as predictors of neonatal care practice. Maternal education of primary (β =0.21; 95%CI: 0.10, 0.32) and secondary or above (β = 0.76; 95%CI: 0.55, 0.98) were found to increase the neonatal care practice significantly as compared with illiterate mothers. Mothers, whose husbands were employed (β = 0.54; 95%CI: 0.30, 0.77) or merchants (β = 0.28; 95%CI: 0.09, 0.47) had higher neonatal care practice as compared to those whose husbands were farmers.

Wealth quintiles of second (β = 0.18; 95%CI: 0.03, 0.31), third (β = 0.30; 95%CI: 0.15, 0.46), fourth (β = 0.41; 95%CI: 0.25, 0.56) and fifth (β = 0.30; 95%CI: 0.14, 0.46) also increased neonatal care practice significantly as compared to the lowest (poorest) wealth quintile. Similarly, inter-birth interval of 2-4 years (β = 0.20; 95%CI: 0.01, 0.39) and above 4 years (β = 0.34; 95%CI: 0.10, 0.58) increased neonatal care practice significantly as compared to interval of < 2years. Birth order had inverse relationship with neonatal care practice. Birth order of 2^{nd}-4^{th} (β = -0.30; 95%CI: -0.52, -0.09) and above 4^{th} (β = -0.43; 95%CI: -0.68, -0.19) significantly reduced neonatal care practice as compared to first-order neonates (Table 5).

The qualitative part also supplemented the quantitative one and the reasons for poor neonatal care were themed as low awareness, low-socio economy, costs and unavailability of transportations. Majority of the respondents had the feeling that most of the women, particularly in the rural areas, are illiterate and have no adequate knowledge about the risks of neonatal health problems and importance of neonatal care. The other major problems repeatedly raised by most of the respondents as barriers to the neonatal care were unavailability of roads and means of transportation and costs of transportation and services to take them to health facility for preventive and curative services. The respondents also emphasized that majority of rural women are poor and give special emphasis to their daily work for family survival and give less attention to the neonatal care.

A 36 years old TBA expressed her sorrow as, *“…many women face problem because of road and transportation unavailability. The community has been trying to carry women after complication in labor. Now, they are helping by burying women because of repeated occurrences and loss of hope….”*

A 30 years old FGD discussant mother added, *„ …Lack of transport is our serious problem. I know one woman in my neighbourhood. She had labour at home for more than a day. We tried to take her to health facility, but no any car around. As a result, we had no options except waiting her till the dead fetus came out ….”*

Discussion

The overall status of neonatal care practice in this study was 59.5%, which is relatively higher than previous study done in Addis Ababa (29%) [21]. However, majority of the components of the neonatal care practice along the continuum of care are still very low. For example, all the four components of neonatal care during pregnancy (receiving TT, planning for birth, attending ANC and receiving adequate information) were less than 50%. Similarly, the coverage of skilled care at birth (conducted at health facility attended by skilled attendant) was very low (17.5 %). These findings are almost comparable with the national figures reported in EDHS 2011[8]. . This low coverage may be explained by the low awareness of mothers about neonatal health problems and the importance of neonatal care that might have lead to low utilization of the cares.

Care of umbilical cord always needs special attention as it can function as the entry point for infections. World Health Organization recommends dry cord care (where nothing is placed on cord stump unless indicated). Various studies done in developing countries have also reported that mothers apply substances like mustard oil, turmeric, cow dung and antiseptic lotion on the cord stump [22-23]. In the contrary, clean cord care practice was found to be better (86.5%) in this study. This may be due to difference in cultural practices in relation to neonatal care. In addition, the current community based interventions by health extension workers might have contributed to the reduction of traditional cord care practices in the study area.

The WHO recommends early initiation of breast milk (within one hour of birth) and avoiding extra feeding up to 6 months of age. In this study, 64.1% of the newborn started breast milk within one hour of birth and 91.5% were on exclusive breast milk during the first 28 days of birth. This is consistent with the finding of the study conducted in Addis Ababa in which 61.4% of newborns started breast milk within the first hour of birth [21]. Similar findings were also reported in studies done in Nigeria (65.3%) [22] and Philippines (68.2%) [23].

In this study, neonatal care practice was higher among mothers from urban residence as compared to the rural mothers. This is consistent with other prior studies [21, 22]. This may be explained by the reason that women in urban areas have access to information and media and more likely to use ANC and skilled care at birth that might have contributed to this difference.

Similarly, neonatal care practice was found to increase significantly as educational status and wealth quintiles increase. Similarly, having employed husband was found to increase neonatal care practice as compared to farmer husband. This is also consistent with other prior studies [21-23]. This may be explained by the reasons that when education increases, knowledge about health care, access to employment and income also increase. When there is high income or better wealth status, mothers are more likely to seek services for both themselves and their neonates.

In this study, first-birth-order neonates received significantly higher care as compared to higher-birth-order neonates. This may be due to the reason that families give special care for first child and this goes down as the number of live children increases sometimes because of negligence and economic issues to give care for all children. Inter-birth interval was another factor affecting neonatal care practice. Birth-interval of two years or above significantly increased neonatal care. This finding is similar with other studies conducted before [21, 22]. The reason could be, when mothers get closely spaced births, they are expected to care for both children and themselves, which may

lead to maternal exhaustion and negligence. As a result, the care for the later one gets decreased.

For policy and program implications, this study came up with the evidence that factors affecting neonatal care practice exist both at the community level as well as at the individual level. However, the community level predictor (place of residence) is more resistant to change. Therefore, interventions must focus on the individual level predictors, which are more feasible to be intervened. Moreover, as multiple factors exist at the individual level, multiple interventions need to be in place along the continuum of care encompassing all the elements of the minimum neonatal care package.

This study may have its own limitations in that all the findings concerning neonatal care practices were based on mothers own reports, which might have been affected by their memories and might introduced some biases. The nature of the principal component analysis (PCA) includes the most important variables that contributed to the variation and excludes some other variables, which might have affected the status of neonatal care estimation. Therefore, it is important to consider these limitations while interpreting the findings of this study.

Conclusions

This study revealed that the status of neonatal care practice in the study area is relatively better. However, there is big variation in the coverage of the components of neonatal care package. Particularly, the coverage of skilled care at birth and vaccination on the date of birth are very low. Factors affecting neonatal care existed both at the cluster as well as at the individual level. Place of residence, maternal education, husband‘s occupation, wealth quintiles, birth order and inter-birth interval were identified as factors affecting neonatal care practice. Therefore, interventions targeting neonatal care should address all the components of the minimum neonatal care package along the continuum of care starting from before pregnancy, during pregnancy, during labor and after birth. Community level interventions need to be strengthened to address closely spaced births, improve ANC and skilled care use. Behaviour change communication (BCC) to the family, particularly mothers, also needs to be strengthened on the risks of neonatal health problems and the importance of neonatal care.

List of abbreviations

ANC: Antenatal Care, BPCR: Birth Preparedness and Complication Readiness, CI: Confidence Interval, FGD: Focus Group Discussion, GO: Governmental Organization, HEW: Health extension worker, IDI: In-depth Interview, MDG: Millennium Development Goal, NGO: Non Governmental Organization, PCA: Principal Component Analysis, TBA: Traditional Birth attendant, TT: Tetanus Toxoid, WHO: World Health Organization

Competing interests

The authors declare that they have no any conflict of interest.

Authors’ contribution

GT involved in the conception of the study. GT, MF and AW involved in the design, data collection process, analysis and interpretations of the findings. GT prepared the initial manuscript which latter be read and edited by MF and AW. The final manuscript was read and approved by all authors.

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Table 1. Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, September 2012-December 2013

Variables	Descriptions	Measurements
Cluster ('*Kebele*')	The smallest administrative unit having about 5000 population on average.	73 '*Kebele*s' (clusters) identified by multistage sampling method were included in the study
Dependent variable		
Neonatal care practice	The minimum neonatal care package adapted from WHO having 12 items were used to produce composite index (score) by using PCA.	The 12 items were measured in "Yes" or 'No' responses. Yes was given a value of '1' and No was given '0'. PCA was done to create composite index (score) .
The 12 items used to produce neonatal care score (index)		
1. Tetanus toxoid (TT) during Pregnancy	The vaccination given for mothers during ANC visit to prevent the mother and her child against Tetanus	Those who received at least 1 dose of TT were coded as 'Yes =1' and otherwise 'No=0'
2. Birth preparedness and complication readiness (BPCR)	A package of interventions composed of 5 variables (Planed to save money, planed to arrange transport, identified place of delivery, identified skilled attendant and identified blood donor)	Composite variable was computed by adding the five responses. Women who scored 3 or more 'Yes' responses were categorized as 'prepared=1' and otherwise 'not prepared = 0'
3. Antenatal care (ANC)	Having health facility visit for pregnancy check up by skilled attendants during pregnancy	Those who had at least one ANC visit were labeled as "Yes=1" and otherwise 'No = 0'
4. Information on neonatal care	Includes 4questions: Information on self care, breast feeding, neonatal feeding and vaccination.	Mothers who received the 4 information were labeled as 'Received adequate information = 1' and otherwise 'No adequate information=0'
5. Skilled care at birth	The place where the neonate was born and the person who assisted the mother during delivery	Deliveries conducted in health facility (hospital or health centre) attended by skilled attendant (Those who have trained to the level of Diploma and above) were categorized as "skilled care = 1", and deliveries conduced at home or anywhere outside a health facility attended by un skilled attendant (family members, TBAs/TTBAs and HEWs) were categorized as 'Unskilled care = 0'
6. Social support during labour	Having accompanying person during labour	Those who had someone (family member/relative) with them during the time of labour and delivery were labeled as 'have social support=1' and otherwise 'No social support = 0'
7. Immediate thermal care	Protecting the newborn from hypothermia by covering with clean close and placing in skin contact with the mother	Neonates wrapped with clan close and placed in skin contact with the mother were labeled as 'appropriate thermal care = 1' and otherwise 'Not appropriate thermal care = 0'.
8. Breast-feeding initiation	The time the newborn first feed breast milk	Those started within 1 hour of birth were labeled as 'timely initiated = 1 ' and otherwise 'delayed initiation= 0'
9. Clean and safe cord care	Using clean instrument to cut and tie the cord and putting nothing on the umbilical stump.	If cut by clean material, tied by clean thread and nothing is put on the stamp, it was labeled as "clean/safe cord care = 1' if any one of these was missing, it was labeled as 'Non-clean cord car = 0.'
10. Exclusive breast feeding of neonate	Giving only breast milk in the first 28 days	Thos who were on breast milk only were labeled as 'on exclusive breast milk = 1' and who started anything, including plain water were labeled as 'Not on exclusive breast milk = 0'.
11. Newborn bathing	Washing the newborn for the first time	Those who were washed after the first 6 hours of birth were labeled as "appropriate bathing=1' and otherwise 'not=0'.
12. Vaccine on date of birth	Includes BCG and polio-0 on the date of birth	Neonates who received the 2 vaccines were labeled as 'received the vaccines on date of birth = 1' if one of them was missing, it was labeled as 'no appropriate immunization on date of birth = 0'

Table 1. Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 ***(Continued)***

Level-2 predictor variables	**Communal (kebele) characteristics**	
Place of residence	The usual place of residence where the woman lives	Rural kebele was coded as '1' and Urban kebele was coded as '2'.
Average distance from health centre	Approximate distance of respondent's home from the nearest health centre on foot in munities as reported by respondent.	Average distance was computed for each kebele and dichotomized as '≤2hours = 1' and '>2hours = 2'
Average distance from Hospital	Approximate distance of respondent's home from the nearest hospital on foot in munities as reported by the respondent.	Average distance was computed for each kebele and categorized as '≤2 hours=1', '>2 hours =2'
Level-1 predictor variables	**Individual and household characteristics**	
Age	Age of women at interview in completed years	Categorized in to 7 groups by five-years interval, which later recoded in to three categories: '<20=1', '20-29=2' or '>29=3'
Ethnicity	The ethnic background of the respondent	Each ethnicity was entered and later recoded as 'Oromo=1' and 'Others=2'. Others were merged because they were very few for logistic regressions.
Religion	The religious background of the respondent	Each religion was entered and later recoded as 'Muslim=1' or 'Others=2'. Others were merged because they were very few for logistic regressions.
Educational status	Highest level of education attained by the respondent and her husband	Categorized in to 4 groups as 'No Formal Education=1', 'primary (1-8)=2', 'Secondary or above (9^{+}=3)
Occupational status	Current employment status and specific occupation of respondent and her husband	Categorized as 'housewife' ('farmer' for husbands)=1, 'employed=2', and 'merchant=3'
Wealth quintiles	Using EDHS questionnaire, house hold assets ownership were assessed and wealth index was computed by using principal component analysis	The wealth status was categorized in to five groups and ranked from poorest to wealthiest quintiles. 'First quintile =1', 'Second quintile = 2', 'Third quintile = 3, 'Fourth quintile = 4' and 'Fifth quintile = 5'.
Birth order	Number of births a woman ever had including current birth	The responses was categorized in to three categories as: '1^{st} birth order =1', '2^{nd} – 4^{th} = 2' and '≥5^{th} birth order = 3'
Preceding birth interval	The duration between the current birth and the preceding birth in months.	The responses were categorized in to three as: '<24 months=1', '24-48 months = 2'' and ''>48 months = 3'.

Table 2. Socio-Demographic characteristics of Respondents, Jimma Zone, Southwest Ethiopia, September 2012-April 2013 (n = 3,463)

Variables	No.	%
Residence		
Urban	861	24.9
Rural	2602	75.1
Age (Years)		
<20	174	5.0
20-29	2209	63.8
≥30	1080	31.2
Ethnicity		
Oromo	3033	87.6
Amhara	169	4.9
Dawuro	96	2.8
Others*	165	4.7
Religion		
Musilim	3019	87.2
Orthodox	345	10.0
Protestant	99	2.9
Educational status		
No formal education	1871	54.0
Primary (1-8)	1270	36.7
Secondary (9-12)	256	7.4
>12	66	1.9
Occupation		
Housewife	3280	94.7
Employed (GO, NGO & Private)	78	2.2
Others‡	105	3.1
Husband's Occupation		
Farmer	2459	71.0
Employed (GO, NGO & Private)	376	10.8
Merchant	413	11.9
Daily laborer	190	5.5
Others‡	25	0.8
Sex of neonates		
Male	1779	51.4
Female	1684	48.6
Types of birth		
Singleton	3387	97.8
Twins	76	2.2

**Yem, Kaficho, Guraghe and Tigrie, † Single, divorced, widowed, ‡Merchant, daily laborer and student, This table is Published with another objective on PLoS ONE 2014; 9(9): doi:10.1371/journal.pone.0107184.t002*

Table 3. Neonatal care practice in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n = 3,463)

Variables	***No.***	***Unweighted %***	***Weighted %***
Received TT during pregnancy (at least 1 dose)	1962	56.7	53.8
Planed for birth and its complications	1202	34.7	23.8
Received skilled ANC Care at least once	1840	53.1	41.9
Adequate information on neonatal care	1501	43.3	43.0
Skilled care at birth	1064	30.7	17.5
Social support during labor and delivery	3268	94.4	95.0
Appropriate immediate thermal care	3359	97.0	96.5
Clean cord care	3042	87.8	86.5
Timely initiation of breast feeding (within 1 hour)	2307	66.6	64.1
Exclusive breast feeding (within 28 days)	3176	91.7	91.5
Appropriate bathing time (>6hrs)	2160	62.4	56.5
Vaccines on date of birth (BCG & Polio 0)	425	12.3	8.1
Over all neonatal care practice			
Good Practice (≥Mean score)	2240	64.7	59.5
Poor Practice (<Mean score)	1223	35.3	40.5

Table 4. Parameter coefficients and test of goodness-of-fit of the mixed effect multilevel model, in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n = 3,463)

Models	Fixed intercept -cons(95%CI)	Random effect as Level-2 variance		Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR) (deviance)	Significance of LR test Vs linear regression (P-value)
		var(-cons (95%CI))	var(Residual (95%CI))			
Empty model	0.25(0.01, 0.49)	1.02(0.72, 1.44)	2.05(1.96, 2.15)	0.332=33.2%	-6269.60	<0.0001
Full model	-0.30(-0.69, 0.09)	0.36(0.25, 0.51)	1.94(1.85, 2.04)	0.157=15.7%	-6143.08	<0.0001

Table 5. Multilevel analysis of factors affecting neonatal care practice, in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n = 3,463)

Variables	Crude estimate β (95%CI)	Adjusted estimate β (95%CI)
Level-2 (higher level)-communal variables		
Place of residence		
Urban	1.63 (1.51, 1.75)	0.86 (0.45, 1.23)
Distance from health centre (on foot)		
>2hours	-0.58 (-0.70, -0.45)	-0.09 (-0.45, 0.27)
Distance from Hospital (on foot)		
>2hours	-1.38 (-1.54, -1.23)	-0.33 (-0.77, 0.11)
Level-1-lower level (individual) variables		
Age (Years)		
20-29	-0.55 (-0.82, -0.2)	-0.21 (-0.44, 0.03)
>29	-0.88 (-1.14, -0.59)	-0.25 (-0.52, 0.11)
Educational status		
Primary education (Grades 1-8)	0.52 (0.41, 0.64)	0.21 (0.10, 0.32)
Secondary or above (Grades ≥9)	1.95 (1.75, 2.14)	0.76 (0.55, 0.98)
Occupation		
Employed	1.20 (0.94, 1.45)	0.18 (-0.06, 0.41)
Husband‘s occupation		
Employed	1.88 (1.71, 2,05)	0.54 (0.30, 0.77)
Merchant	1.28 (1.14, 1.42)	0.28 (0.09, 0.47)
Wealth index		
Second quintile	0.45 (0.27, 0.63)	0.18 (0.03, 0.31)
Third quintile	0.57 (0.38, 0.75)	0.30 (0.15, 0.46)
Fourth quintile	0.70 (0.52, 0.88)	0.41 (0.25, 0.56)
Fifth quintile	0.72 (0.54, 0.90)	0.30 (0.14, 0.46)
Birth order		
2^{nd} -4^{th}	-0.58 (-0.73, -0.44)	-0.30 (-0.52, -0.09)
$\geq 5^{th}$	-1.07 (-1.24, -0.91)	-0.43 (-0.68, -0.19)
Birth interval		
24-48 Months	0.34 (0.12, 0.56)	0.20 (0.01, 0.39)
>48 Months	0.93 (0.65, 1.21)	0.34 (0.10, 0.58)

N/A=Not applicable

Annex 1.5. Tura G, Fantahun M, Worku A. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: a multilevel analysis of prospective follow up study. PLoS ONE 9(9): e107184. doi:10.1371/journal.pone.0107184.

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Determinants and Causes of Neonatal Mortality in Jimma Zone, Southwest Ethiopia: A Multilevel Analysis of Prospective Follow Up Study

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Abstract

Background: Ethiopia is among the countries with the highest neonatal mortality with the rate of 37 deaths per 1000 live births. In spite of many efforts by the government and other partners, non-significant decline has been achieved in the last 15 years. Thus, identifying the determinants and causes are very crucial for policy and program improvement. However, studies are scarce in the country in general and in Jimma zone in particular.

Objective: To identify the determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia.

Methods: A prospective follow-up study was conducted among 3463 neonates from September 2012 to December 2013. The data were collected by interviewer-administered structured questionnaire and analyzed by SPSS V.20.0 and STATA 13. Verbal autopsies were conducted to identify causes of neonatal death. Mixed-effects multilevel logistic regression model was used to identify determinants of neonatal mortality.

Results: The status of neonatal mortality rate was 35.5 (95%CI: 28.3, 42.6) per 1000 live births. Though significant variation existed between clusters in relation to neonatal mortality, cluster-level variables were found to have non-significant effect on neonatal mortality. Individual-level variables such as birth order, frequency of antenatal care use, delivery place, gestation age at birth, premature rupture of membrane, complication during labor, twin births, size of neonate at birth and neonatal care practice were identified as determinants of neonatal mortality. Birth asphyxia (47.5%), neonatal infections (34.3%) and prematurity (11.1%) were the three leading causes of neonatal mortality accounting for 93%.

Conclusions: This study revealed high status of neonatal mortality in the study area. Higher-level variables had less importance in determining neonatal mortality. Individual level variables related to care during pregnancy, intra-partum complications and care, neonatal conditions and the immediate neonatal care practices were identified as determinant factors. Improving antenatal care, intra-partum care and immediate neonatal care are recommended.

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Data Availability: The authors confirm that all data underlying the findings are fully available without restriction. All the necessary data were included in the paper. However, the raw data set in SPSS or STATA can be obtained by email request at gurmesatura@gmail.com.

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Introduction

Globally, about 6.6 million children die before their 5th birthday each year. About 5 million of this occurs in the first year of life and nearly 3 million die within the first 28 days of birth. This indicates that about 44% of under-five deaths and 60% of infant deaths are accounted by the neonatal mortality. Moreover, the share of neonatal mortality from the under-five death rose from 37% in 1990 to 44% in 2012 [1]. This clearly points out that it is difficult to achieve the desired millennium development goal (MDG_4) target for the two-thirds reduction of child mortality by 2015 without particular focus on neonatal mortality.

More than 98% of these deaths occur in developing countries. Sub-Saharan Africa has the highest risk of death in the first month of life and among the regions showing the least progress in reducing the neonatal mortality rate. Most of these deaths are caused by infectious diseases, pregnancy-related complications, delivery-related complications, including intra-partum asphyxia, birth trauma and premature birth which can easily be prevented [1,2].

In Ethiopia, neonatal mortality rate (NMR) has long been very high. In spite of many efforts by the government and other stakeholders, non-significant and very sluggish decline has been

achieved in the last 15 years. The neonatal mortality rate for the years 1991–1995, 1996–2000, 2001–2005 and 2006–2011 were 46, 42, 39 and 37 per 1000 live births, respectively [3,4,5]. Moreover, about 63% of infant deaths in the country occur during the first month of life. Thus, accelerated reduction in neonatal mortality is increasingly critical for progress towards the MDG_4.

To do this, identifying the determinants and causes of neonatal mortality at the local context is very crucial and timely issue. However, many of the neonatal deaths happen at home and unrecorded that make obtaining sampling-frame and sources of data very difficult. As a result, studies on this topic including verbal autopsies (VAs) are limited in Ethiopia. Moreover, the very few available studies are only facility-based and cross-sectional in design, which are not the preferred designs to establish causal relationships necessitating community-based prospective study supported by verbal autopsy (VA).

Therefore, this longitudinal community based study aimed to fill these gaps by determining the status of neonatal mortality and identifying the determinants and causes at different levels by applying multilevel analysis. The findings of the study will also be used as inputs for policy makers and program implementers at national as well as regional levels to design evidence-based intervention strategies to tackle the problems of neonatal mortality.

Methods and Materials

Study design and setting

This study was a community-based prospective follow up conducted in Jimma Zone from September 2012-December 2013. Jimma Zone is one of the 17 Zones of the Oromia Regional State of Ethiopia having a total of 17 rural districts and two town administrations. According to the 2007 national population and housing census, the Zone has a total population of 2.6 million, of which 88.7% are rural residents [6,7].

Sample size and sampling technique

The minimum required sample size for this study was determined by using Epi-Info V.3.5.1 by considering two sample comparisons of proportions based on the following assumptions. The outcome variable was neonatal mortality. Among all the determinants of neonatal mortality considered, educational status of mothers was found to give the largest sample size. Based on this, the prevalence of neonatal mortality among mothers having educational status of secondary or above was estimated to be 4.0% ($P_1 = 0.040$) and among those who didn't attend secondary education was to be 8.1% ($P_2 = 0.081$) [8]; 95% level of confidence and 80% power were considered. A ratio of 1:3 was used ($r = 3$). As multistage-clustered sampling method was used, a design effect of 2 was considered. Finally, 10% was added for non-responses and miss-to-follow up and the final sample size became 3604.

Multistage-clustered sampling technique was used to identify a cohort of pregnant women to be enrolled in the follow up for the study. At first stage, the Zone was stratified as rural districts (17 in number) and town administrations (2 in number, Jimma and Agaro). Then, by considering time and logistics, 5 districts (30%) were selected by simple random sampling from the 17 districts. At second stage, all the selected 5 districts were clustered by 'Kebeles' (A 'kebele' is the smallest administrative unit having 5000 population in average) and stratified in to urban and rural 'Kebeles'.

Then, by simple random sampling method, 9 rural 'Kebeles' and 2 urban 'Kebeles' were selected from each selected district. This number of clusters ('kebeles') was determined based on expected number of pregnant women per 'Kebele'. Jimma town administration and Agaro town administration have 13 and 5 'Kebeles', respectively and all were included purposefully. With this, a total of 73 Clusters ('Kebeles') were included in the study. Then, for all selected 'kebeles', pregnant women were enumerated by using house-to-house visit and all obtained were enrolled in the study (Figure S1).

Measurements

The dependent variable for this study was neonatal mortality and the independent variables were divided into two levels. Level 2 (higher-level variables) included community or cluster level variables such as place of residence, access to health centers and access to hospitals. Level 1 (lower-level variables) included individual and household characteristics such as: socio-demography, wealth quintiles, maternal obstetric factors, maternal health care use, conditions of labor, characteristics of the neonates and neonatal care practices. The detail descriptions and measurements are given below (Table 1).

Instruments

The data were collected by using pre-tested interviewer administered structured questionnaires which were adapted from different literatures. The indicators for the wealth index were adapted from Ethiopian Demographic and Health Survey (EDHS) [5]. Indicators to measure birth preparedness and complication readiness (BP & CR) were adapted from the safe motherhood questionnaires developed by maternal and neonatal health program of Johns Hopkins Program for International Education in Gynecology and Obstetrics (JHPIEGO) [9]. Indicators for neonatal care practices were adapted from the World Health Organization (WHO) minimum neonatal care packages [10]. Data on causes of neonatal death were collected by using structured verbal autopsy questionnaire adapted from the standard VA questionnaire developed and validated by WHO, Johns Hopkins University (JHU) and London School of Hygiene and Tropical Medicine [11]. All the questionnaires were prepared in English, then translated to local languages 'Afan Oromoo' and Amharic and used to collect the data after back translating to English by different experts to check its consistency.

Data collection process

As this was prospective follow up study, data were collected in three phases. First, home-to-home visit was made to enumerate pregnant women from the selected 73 clusters. Then, all the identified pregnant women were enrolled in the study as a cohort. At a baseline, data on basic socio-demography, economy and birth preparedness and complication readiness were collected. Then, just at the end of neonatal period, maternal service use (antenatal care (ANC), delivery place and attendant and postnatal care), conditions of labor, neonatal characteristics and neonatal care practices were collected. For died neonates, VAs were conducted within 15–30 days of death.

Females, who had completed 10^{th} grade or above were recruited, trained and collected the data. The VAs were conducted by two experienced females. The data collection process was supervised strictly by trained supervisors and principal investigators. To control the quality of data, in addition to training, pretest, supervision and use of local languages, the inter-item consistency of the indicators to measure the composite score of wealth index, BP & CR and neonatal care practices were checked by using Chronbach-alpha at 0.7 cut-off points.

Table 1. Description of variables and measurement for the study, Jimma Zone, Southwest Ethiopia, September 2012-December 2013.

Variables	Descriptions	Measurements
Dependent variable		
Neonatal mortality	Death of the infant before 28 completed days	Neonates died before 28 days were categorized as neonatal death and coded as '1', those survived 28 days were coded as '0'
Level-2 predictor variables	Communal (kebele) characteristics	
Place of residence	The usual place of residence where the woman lives	Urban kebele was coded as '1' and rural kebele was coded as '0'.
Average distance from health centre	Approximate distance of respondent's home from the nearest health centre on foot in munities as reported by respondent.	Average distance was computed for each kebele and dichotomized as '≤2 hours' and '>2 hours'
Average distance from Hospital	Approximate distance of respondent's home from the nearest hospital on foot in munities as reported by the respondent.	Average distance was computed for each kebele and categorized as '≤2 hours', '>2–12 hours' or '>12 hours'
Level-1 predictor variables	Individual and household characteristics	
Age	Age of women at interview in completed years	Categorized in to 7 groups by five-years interval, which later recoded in to three categories: '<20', '20–29' or '>29'
Ethnicity	The ethnic background of the respondent	Each ethnicity was entered and later recoded as 'Oromo' and 'Others'. Others were merged because they were very few for logistic regressions.
Religion	The religious background of the respondent	Each religion was entered and later recoded as 'Muslim' or 'Others'. Others were merged because they were very few for logistic regressions.
Educational status	Highest level of education attained by the respondent and her husband	Categorized in to 4 groups as 'no Formal Education', 'primary (1–8)', 'Secondary (9–12)' and 'tertiary (12+)'.
Occupational status	Current employment status and specific occupation of respondent and her husband	Categorized as 'housewife' ('farmer' for husbands), 'employed', 'merchant' and 'others'.
Wealth quintiles	Using EDHS questionnaire, house hold assets ownership were assessed and wealth index was computed by using principal component analysis	The wealth status was categorized in to five groups and ranked from poorest to wealthiest quintile.
Birth order	Number of births a woman ever had including current birth	The responses was categorized in to three categories as: '1st birth order', '2nd–4thv and "≥5th birth order'
Preceding birth interval	The duration between the current birth and the preceding birth in months.	The responses were categorized in to three as: '<24 months, '24–48 months' and ">48 months. First birth orders were categorized as 'Nuliparous.'
Birth preparedness and complication readiness	A package of interventions composed of composite measure of 5 variables (planed to save money, planed to arrange transport, identified place of delivery, identified skilled attendant and identified blood donor)	Composite variable was computed by adding the five responses. Women who scored 3 or more 'Yes' responses were categorized as 'prepared' otherwise 'not prepared'
ANC frequency	Having health facility visit for pregnancy check up by skilled attendants during pregnancy.	Categorized in to three: 'No ANC visit at all', '1–3 ANC visits' and '≥4 ANC visits'
Place of delivery	The place where the neonate was born	Categorized as 'home', 'Hospital' and 'Health centre'.
Attendant of delivery	The person who assisted the mother during delivery	Those who have trained to the level of Diploma and above was categorized as "skilled attendants'', those who didn't train at all, TBAs/TTBAs and HEWs were categorized as 'Unskilled attendants'
Gestation age at birth	Approximate GA at birth by woman's own report in weeks	GA of <37 weeks were categorized as 'Premature birth' and GA of ≥37 weeks were categorized as 'Mature birth'.
Premature rupture of membrane (PROM)	Leakage of fluid before the onset of labor and the duration it stayed before the onset of labor in hours.	The responses were Categorizes in to four as: 'No leakage before onset of labor'", '<1 hour', '1–12 hours' and '>12 hours'.
Duration of labor	The time between the onset of labor to the expulsion of the foetus	Categorized in to three as: '<6 hours', '6–12 hours' and '>12 hours'.
Complications during labor	The occurrence of one or more of the following complications: excessive bleeding, mother had convulsions, breech presentation, emergency C/S and multiple delivery.	The responses were categorized as 'Yes' if at least any one complication and otherwise categorized as 'No'.
Type of birth	Multiplicity of the birth (whether the delivery was multiple or singleton)	Twin births were labeled as '1' and singletons were labeled as '0'
Sex of neonate	The sex of the neonate, both for died and alive.	Males were coded as '1' and females were coded as '0'.
Size of neonate at birth	Size of their neonate at birth as judged by the mother as compared to other average neonates they know before.	The responses were categorized in to 5 as: 'very small', 'small' 'average', 'big' and 'very big' which later recoded in to three as "Small', average' and big' by merging the lower two as well as the upper two categories.

Table 1. Cont.

Variables	Descriptions	Measurements
Dependent variable		
Neonatal care	The minimum neonatal care packages adapted from WHO having 12 items were used to produce composite index by using PCA.	Mean score was computed for the index and those scored above or equal to the mean were categorized as having 'good neonatal care' and those scoring less than the mean were categorized as 'poor neonatal care'.

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Data management and analysis

The collected data were coded and entered into Epidata V.3.1 to minimize logical errors and design skipping patterns. Then, the data were exported to SPSS for windows version 20.0 for cleaning, editing and analysis. Descriptive analysis was done by computing proportions and summary statistics. Socioeconomic quintiles were determined by using Principal Component Analysis (PCA). Birth preparedness and complication readiness was computed by composite indicator of five items. Similarly, neonatal care practice was determined by composite variable of 12 items by using PCA. As Jimma and Agaro town administrations were both purposefully included, the status of neonatal mortality was estimated by calculating weighted percentage based on the complex sample survey procedure to avoid underestimation.

Bivariate analysis was done by using cross-tabulation to see associations between the dependent and independent variables. Then, all variables having P-value <0.25 were considered as candidates for the final model. As multistage-clustered sampling technique was used because of the different levels of factors, mixed-effects multilevel logistic regression model was used by using STATA 13. This model was preferred in order to avoid the clustering effects as well as ecological fallacy. 'Kebeles' were considered as clusters and 'kebele' level variables were taken as higher-level (level 2). Neonates were nested within their family and households. As a result, neonatal individual variables, delivery conditions and household characteristics were taken as lower level (level 1) variables (Table 1).

Goodness of fit of the multilevel model was tested by the log likelihood ratio (LR) test. To evaluate the extent of the cluster variation in influencing neonatal mortality, intercept-only model was fitted as Logit $(p_{ij}) = \gamma_{00}+u_{0j}$ and Interclass Correlation Coefficient (ICC = ρ) was determined by dividing variance between groups ($\delta^2\mu_0$) by variance between groups ($\delta^2\mu_0$) plus variance within groups ($\delta^2 e$). However, within group variance ($\delta^2 e$) can't be directly obtained for dichotomous outcome variables; instead, it was estimated by dividing $\delta^2\mu_0$ by $\delta^2\mu_0$ plus $\Pi^2/3$. Then, to identify the determinant factors, the full model was fitted as: $\text{Logit}(p_{ij}) = \gamma_{00} + \gamma_{01} Z_j + \gamma_{10} X_{ij} + u_{0j} + u_{1j} X_{ij}$. Where: $\text{Logit}(p_{ij})$ = dependent variable at unit i in cluster j, X_{ij} = individual explanatory variable in cluster j, Z_j = group level explanatory variable, γ_{00} = fixed intercept, γ_{01} and γ_{10} = fixed slopes and u_{0j} and u_{1j} = random effects at level 2.

Multicollinearity between the independent variables was assessed by using variance inflation factors (VIF>10 considered as existence of multicollinearity) before interpreting the final output. However, only skill of delivery attendant (VIF = 10.9) had multicollinearity with place of delivery (VIF = 9.1, reduced to 1.8 when delivery attendant was dropped). As a result, they were included in the model alternatively by dropping the other. For the rest of the variables, the VIF was <3. In addition, cross-level two-way interactions were checked, particularly between place of residence, access to health facilities and maternal health care use (ANC, place of delivery and delivery attendants). Individual-level two-way interactions between prematurity (gestation age at birth), twin births and size of neonate at birth were checked. However, no significant interaction was detected (P>0.05 for each). The VAs were interpreted by two independent pediatricians and third pediatrician interpreted in case of disagreements.

Ethical consideration

Ethical approval was obtained from the Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University as well as IRB of Oromia Regional State Health Bureau. Following this, formal letters and permissions were secured from all respective local administrators. Written informed consent was obtained from each respondent before actual data collection. Issues of confidentiality were maintained by removing any identifiers from the questionnaire. To protect vulnerable group, data collectors were trained to maintain confidentiality and provide necessary health information based on the need of the participants and arrange referral to health facilities for sick neonates.

Results

Response rate

It was planned to include a sample of 3604 neonates. However, after excluding incomplete questionnaires, abortion cases, missed-to-follow up, maternal deaths and stillbirths, a total of 3463 live-births were included in the analysis for this study making a response rate to be 96.1%.

The detail process and flow of the study is indicated below (Figure 1).

Socio-demographic characteristics

Of the total 3463 live-births included in the analysis, 2602(75.1%) were from urban residence. Majority, 2209(63.8%), of the mothers of the neonates were in the age group of 20–29 years with a mean and standard deviation of 26.6±5.0. Oromoo was the dominant ethnic group, 3033(87.6%) and Muslim was the leading religion, 3019(87.2%). More than half of the mothers, 1871(54.0%), didn't attend any formal education. The great majority, 3280(94.7%), of the mothers were housewives and farmer was the leading occupation of their husbands, 2459(71.0%). Nearly half, 1779(51.4%), of the neonates were males with male-to-female ratio of 1.06:1.00. The rate of twin births was 76(2.2%) (Table 2).

Status of neonatal mortality

From a total of 3463 live-births, 110 died before 28 days of birth making weighted neonatal mortality rate of 35.5 (95%CI: 28.3, 42.6) per 1000 live-births (urban = 20.0 (95%CI: 9.0, 31.0) and

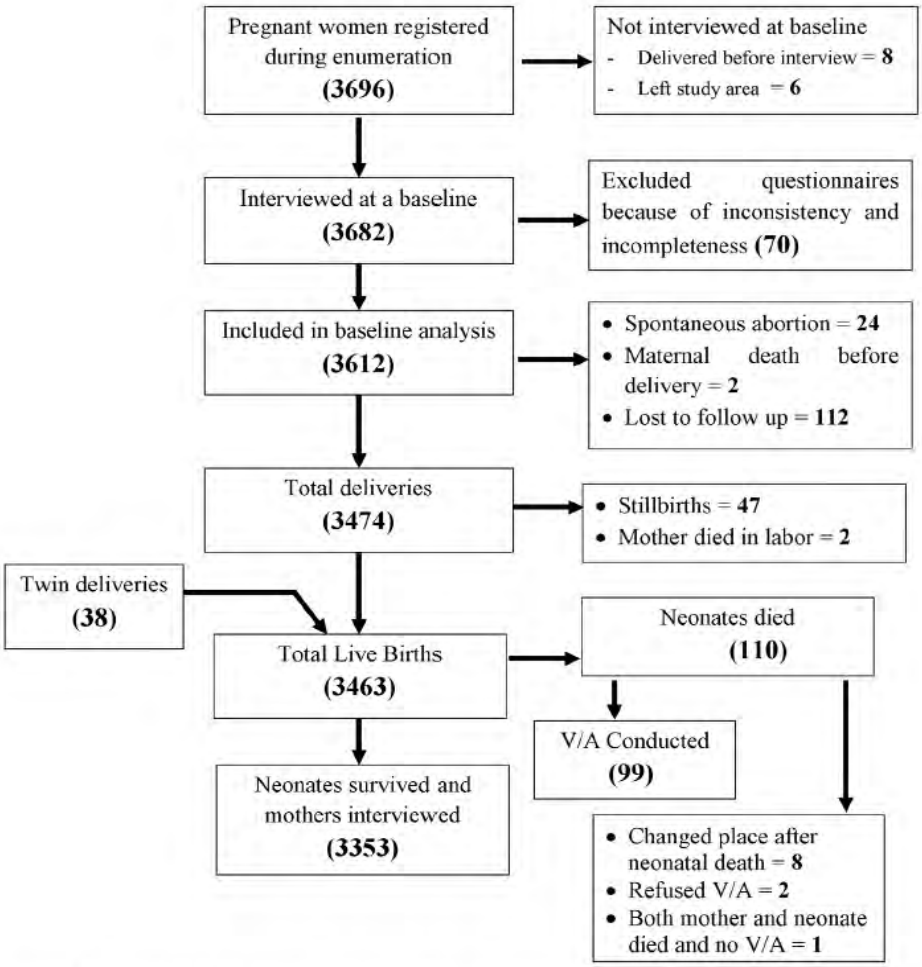

Figure 1. Flow-diagram of the overall study process, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013. This figure shows that a total of 3696 pregnant women were obtained during enumeration. After excluding 14 women because of different reasons, 3682 women were interviewed at a baseline. Again after excluding 70 incomplete and inconsistent questionnaires, 3612 were included in the analysis and enrolled in the follow up. After the follow up, total of 3472 deliveries happened; among which 38 were twins and 47 were stillbirths. From the total of 3463 live births, 110 died before 28 days.
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rural 36.2 (95%CI: 28.7, 43.7). From these, 76(69.1%) died within the first week of life making weighted early neonatal mortality rate to be 23.7 (95%CI: 18.5, 30.3). In this study, 47 stillbirths happened making a stillbirth rate and perinatal mortality rate to be 16.5 (95%CI: 12.2, 22.4) and 39.8 (95%CI: 32.9, 48.1) per 1000 births, respectively (Table 3).

Determinants of neonatal mortality

To evaluate the applicability of the mixed-effects multilevel logistic regression model, the ICC (ρ) was calculated in the empty model and it was found to be 0.100 indicating that 10.0% of the variation is contributed by between-cluster variation. The test of the preference of log likelihood Vs logistic regression was also strongly significant (P = 0.0003). Then, the full model was run by including all the cluster level and individual level variables and the ICC (ρ) was increased to 0.174 suggesting model improvement. This again indicated that 17.4% of the variation is attributed to cluster level variables suggesting the preference of multilevel analysis. The preference of log likelihood Vs logistic regression was again improved and strongly significant (P = 0.0001) (Table S1).

After adjusting in the final two-level mixed-effects logistic regression model, cluster level variables (place of residence, access to BEmOC and CEmOC) had non- significant associations with neonatal mortality. Similarly, among the lower level variables maternal socio demography and economy such as age, education, occupation and wealth quintiles had non-significant associations. Whereas, maternal obstetric and health care during pregnancy and delivery, delivery conditions, neonatal conditions and neonatal care practice had significant associations.

First birth order (OR = 5.45; 95%CI: 1.81, 16.40) and birth order of 5^{th} or above neonates (OR = 2.61; 95%CI: 1.43, 4.74) were more likely to die during neonatal period as compared to 2^{nd}–4^{th} order. Those whose mothers had 1–3 ANC visits (OR = 0.51; 95%CI: 0.28, 0.93) and 4 or more visits (OR = 0.35; 95%CI: 0.18, 0.68) were less likely to die during neonatal period as compared to those who had no ANC visit at all. Neonates born at health centers were 43% (OR = 0.43; 95%CI: 0.17, 0.99) less likely to die during neonatal period as compared to those who were born at home. However, hospital delivery (OR = 0.73; 95%CI: 0.31, 1.70) and skilled attendants

Table 2. Socio-Demographic characteristics of Respondents, Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n = 3463).

Variables	No.	%
Place of residence		
Urban	861	24.9
Rural	2602	75.1
Age (Years)		
<20	174	5.0
20–29	2209	63.8
≥30	1080	31.2
Ethnicity		
Oromo	3033	87.6
Amhara	169	4.9
Dawuro	96	2.8
Others*	165	4.7
Religion		
Musilim	3019	87.2
Orthodox	345	10.0
Protestant	99	2.9
Educational status		
No formal education	1871	54.0
Primary (1–8)	1270	36.7
Secondary (9–12)	256	7.4
>12	66	1.9
Occupation		
Housewife	3280	94.7
Employed (Gov't, NGO & Private)	78	2.2
Others‡	105	3.1
Husband's Occupation		
Farmer	2459	71.0
Employed (Gov't, NGO & Private)	376	10.8
Merchant	413	11.9
Daily laborer	190	5.5
Others‡	25	0.8
Sex of neonates		
Male	1779	51.4
Female	1684	48.6
Types of birth		
Singleton	3387	97.8
Twins	76	2.2

*Yem, Kaficho, Guraghe & Tigrie,
†Single, divorced & widowed,
‡Merchant, student, daily laborer.
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(OR = 0.57; 95%CI: 0.28, 1.16) had non-significant association as compared to home delivery and non skilled attendants, respectively. Prematurity (GA at birth <37weeks) was found to increase the likelihood of neonatal death as compared to term births (OR = 2.09; 95%CI: 1.03, 4.22). Premature and prolonged rupture of membrane before the onset of labor had increased the likelihood of neonatal death. Rupture of membrane 1–12 hours (OR = 2.71; 95%CI: 1.13, 6.53) and >12 hours (OR = 7.74; 95%CI: 2.27, 26.38) before the onset of labor had significantly higher risk of neonatal death as compared to rupture of membrane after the onset of labor.

The occurrence of obstetric complications during labor (OR = 6.77; 95%CI: 3.82, 12.00) and twin births (OR = 8.21; 95%CI: 3.46, 19.47) were among the strong predictors of neonatal mortality. Similarly, small size (OR = 1.95; 95%CI: 1.11, 3.42) and big size (OR = 10.73; 95%CI: 5.65, 20.37) at birth were found to increase the likelihood of neonatal death as compared to average size neonates. Not having good comprehensive neonatal

Table 3. The status of neonatal mortality in Jimma Zone, Southwest Ethiopia, September 2012-December 2013 (n = 3463).

Events	No.	Rate/10^3 (95%CI) (unweighted)	Rate/10^3 (95%CI) (weighted)
Total births	3510		
Total live-births	3463		
Stillbirths	47	13.4(10.1, 17.8)	16.5(12.2, 22.4)
Early neonatal mortality	76	22.0(17.6, 27.4)	23.7(18.5, 30.3)
Late neonatal mortality	34	9.8(7.0, 13.7)	11.8(8.2, 16.9)
Perinatal mortality	123	35.1(29.5, 41.7)	39.8(32.9, 48.1)
Neonatal mortality	110	31.8(26.4, 38.2)	35.5(28.3, 42.6)

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care practice was the other strong predictor of neonatal mortality (OR = 10.36; 95%CI: 5.13, 20.94) (Table 4).

Causes of neonatal mortality

Out of the total 110 neonatal deaths occurred, VAs were conducted for 99 cases. Initially, the two interpreting physicians agreed on the most probable cause of death for 86 out of 99 cases, which was 86%. For 6 (6.1%) of the cases, first and second most probable causes were exchanged between the physicians making the overall agreement rate to be 93%. As a result, third physician interpreted the 13 cases and agreed with either of the physicians in 11 cases and the rest 2 cases were not agreed upon and classified as unspecified cause of death. With this, birth asphyxia (47.5%), neonatal infections (34.3%) and prematurity (11.1%) were the three leading causes of neonatal mortality (Figure 2).

Discussions

The status of neonatal mortality rate in this study is 35.5 (95%CI: 28.3, 42.6) per 1000 live births. This is similar with the finding of the EDHS 2011 in which NMR was 37.0 (95%CI: 33.7, 40.3) [5]. However this is higher than the findings of other countries with high neonatal mortality like India (19.5) [12] and Indonesia (23.8) [13]. This clearly indicated that the situation of neonatal mortality is still high and non-progressing suggesting targeted interventions by all partners at different levels.

In this study, 63 (57.3%) and 76 (69.1%) out of the 110 died neonates occurred on the date of birth and in the 1st week of life, respectively making early NMR to be 23.7 per 1000 live-births. This is in line with other prior studies in which more than three-quarter of neonatal deaths occurred in the first week of life [13–17]. The reason could be majority of neonatal mortality in developing countries are related to conditions of labor, intra-partum and the immediate newborn care practices. Moreover, the major causes of death are birth asphyxia, early neonatal infections and prematurity. This again clearly pointed out that neonatal survival interventions have to target the intra-partum as well as immediate and early neonatal periods.

In this study, higher-level factors (place of residence, access to health centre and hospital) were found to be less important in predicting neonatal mortality. Similarly, lower level factors related to basic socio-demography and economy were less important. Instead, lower level factors related to maternal and neonatal complications and care before, during and after delivery were the most important predictors of neonatal mortality. This finding is consistent with some other prior studies in which higher level variables had less importance in determining neonatal mortality [14,16,18,19]. However, this finding is in contrast to the findings of study done in rural India in which both the higher and lower level factors were equally important [12]. This pointed out that the higher-level factors that are less amenable to short term interventions, have to be considered as distant factors and special focus needs to be given to the immediate proximal factors of neonatal mortality which are more feasible to be intervened.

First birth order and birth order of five or above were found to increase the likelihood of neonatal mortality by more than five and two times respectively. This may be due to high risk of occurrence of complications during delivery among nuliparous and grand-multiparous mothers. In this study, having ANC visit and giving birth at health center were found to decrease neonatal mortality significantly. This is consistent with previous study conducted in Ethiopia and other countries [13,20]. This may be because; during ANC visits, necessary health condition of mothers can be screened and treated earlier. Moreover, health facility delivery is very necessary in detecting complications earlier and providing clean and safe delivery.

In the contrary, delivery at hospital and skilled attendants at birth had no significant association with neonatal mortality. Similarly, in the systematic review and meta-analysis we conducted before this study, in 9 of the 19 studies included, health facility delivery had no significant effect on neonatal mortality [21]. Similar findings have been reported in some other studies in the country and abroad [15,22]. This may be because, majority of hospital deliveries in developing countries, including Ethiopia, are as a result of self referral after all attempts failed. In this study for example, 43.5% of hospital deliveries were because of occurrence of problems during labor. This highlighted the importance of addressing the first and the second delays. This means, giving birth at hospital attended by skilled attendant may not be a guarantee to avert neonatal mortality unless the woman comes to the right health facility at the right time. The other possible explanation could be the low coverage of hospital delivery and skilled attendant at birth that lead to low power to detect significant effects.

Intra-partum conditions, neonatal conditions and immediate neonatal care practices were the most important determinants of neonatal mortality in this study. Prematurity (<37weeks of GA at birth) and the occurrence of maternal complications during labour were found to increase the likelihood of neonatal mortality by two times and nearly seven times, respectively. Similarly, rupture of membrane within 1–12 hours and >12 hours before the onset of labor had increased neonatal mortality by nearly three times and eight times, respectively. Twin births was also increased the risk of neonatal mortality by eight times as compared to singletons. Small size and big size at birth were increased the likelihood of neonatal mortality by about two and eleven times, respectively. Neonates having poor neonatal care were about ten times more likely to die

Table 4. Multilevel analysis of factors associated with neonatal mortality, Jimma Zone, Southwest Ethiopia, Sept 2012-Dec 2013.

Variables	Neonatal Mortality			Crude OR(95%CI)	Adjusted OR(95%CI)
	Died (n = 110) n(%)	Survived (n = 3353) n(%)	Total (n = 3463) n(%)		
Higher level variables					
Place of residence					
Urban	18(2.1)	843(97.7)	861(100.0)	1.00	1.00
Rural	92(3.5)	2510(96.5)	2602(100.0)	1.72(1.03, 2.86)	1.08(0.33, 3.57
Average distance from Health centre (on foot)					
≤2 hours	77(3.1)	2417(96.9)	2494(100.0)	1.00	1.00
>2 hours	33(3.4)	936(96.6)	969(100.0)	1.12(0.73,1.68)	1.06(0.49, 2.32)
Average distance from Hospital (on foot)					
≤2 hours	10(1.9)	519(98.1)	529(100.0)	1.00	1.00
>2 hours	100(3.4)	2834(96.6)	2934(100.0)	1.83(0.95, 3.53)	1.92(0.34, 4.20)
Level-1 variables					
Age of mother at birth					
15–19	3(1.7)	171(98.3)	174(100.0)	1.00	1.00
20–29	64(2.9%)	2145(97.1)	2209(100.0)	1.70(0.53, 5.47)	3.39(0.81, 14.21)
>29	43(4.0)	1037(96.0)	1080(100.0)	2.36(0.73, 7.70)	4.04(0.87, 18.71)
Educational status of mother					
Illiterate	69(3.7)	1802(96.3)	1871(100.0)	1.00	1.00
Primary(1–8)	37(2.9)	1233(97.1)	1270(100.0)	0.78(0.52, 1.18)	0.96(0.56, 1.66)
Secondary or above (≥9)	4(1.2)	318(98.8)	322(100.0)	0.33(0.12, 0.91)	0.52(0.13, 2.13)
Mother's occupation					
Unemployed (housewife)	107(3.3%)	3173(96.7)	3280(100.0)	1.00	1.00
Employed	3(1.6)	180(98.4)	183(100.0)	0.50(0.16, 1.58)	0.41(0.10, 1.81)
Father's occupation					
Farmer	86(3.5)	2372(96.5)	2458(100.0)	1.00	1.00
Employed	6(1.6)	370(98.4)	376(100.0)	0.45(0.19, 1.03)	1.32(0.36, 4.84)
Merchant	18(2.9)	611(97.1)	629(100.0)	0.81(0.49, 1.36)	1.92(0.79, 4.66)
Wealth quintiles					
First quintile	30(4.4)	648(95.6)	678(100.0)	1.00	1.00
Second quintile	24(3.4)	679(96.6)	703(100.0)	0.76(0.44, 1.32)	0.87(0.43, 1.74)
Third quintile	24(3.5)	665(96.5)	689(100.0)	0.78(0.45, 1.35)	1.02(0.51, 2.04)
Fourth quintile	17(2.4)	680(97.6)	697(100.0)	0.54(0.30, 0.99)	1.01(0.47, 2.15)
Fifth quintile	15(2.2)	681(97.8)	696(100.0)	0.48(0.25, 0.89)	0.72(0.32, 1.62)
Birth order					
1st	28(3.8)	703(96.2)	731(100.0)	2.00(1.20, 3.28)	5.45(1.81, 16.40)
2nd–4th	36(2.0)	1793(98.0)	1829(100.0)	1.00	1.00
5th or above	46(5.1)	857(94.9)	903(100.0)	2.67(1.72, 4.17)	2.61(1.43, 4.74)
Preceding birth interval					
<24 months	8(3.1)	247(96.9)	255(100.0)	1.00	1.00
24–48 months	62(2.9)	2095(97.1)	2157(100.0)	0.91(0.43, 1.93)	1.34(0.49, 3.65)
>48 months	12(3.8)	308(96.2)	320(100.0)	1.20(0.48, 2.99)	2.23(0.66, 7.57)
Nuliparous	28(3.8)	703(96.2)	731(100.0)	NA	NA
Birth preparedness plan					
Prepared	28(2.3)	1174(97.7)	1202(100.0)	1.00	1.00
Not prepared	82(3.6)	3353(96.8)	3463(100.0)	1.58(1.02, 2.44)	1.00(0.55, 1.84)
Frequency of ANC					
No visit at all (0)	32(3.9)	787(96.1)	819(100.0)	1.00	1.00

Table 4. Cont.

Variables	Neonatal Mortality			Crude OR(95%CI)	Adjusted OR(95%CI)
	Died (n = 110) n(%)	Survived (n = 3353) n(%)	Total (n = 3463) n(%)		
1–3 visits	44(3.1)	1362(96.9)	1406(100.0)	0.80(0.50, 1.26)	0.51(0.28, 0.93)
≥4 visits	34(2.7)	1204(97.3)	1239(100.0)	0.70(0.43, 1.14)	0.35(0.18, 0.68)
Place of delivery					
Home	83(3.5)	2316(96.5)	2399(100.0)	1.00	1.00
Hospital	17(3.9)	418(96.1)	435(100.0)	1.14(0.67, 1.93)	0.73(0.31, 1.70)
Health centre	10(1.6)	619(98.4)	629(100.0)	0.45(0.23, 0.87)	0.43(0.17, 0.99)
Attendant of delivery					
Non skilled	83(3.5)	2316(96.5)	2399(100.0)	1.00	1.00
Skilled	27(2.5)	1037(97.5)	1064(100.0)	0.73(0.47, 1.13)	0.57(0.28, 1.16)
Gestation age at birth					
Term (≥37 weeks)	90(2.9)	3030(97.1)	3120(100.0)	1.00	1.00
Preterm (<37 weeks)	20(5.8)	323(94.2)	343(100.0)	1.09(1.27,3.43)	2.09(1.03, 4.22)
Premature rupture of membrane					
No(during labor)	84(2.9)	2773(97.1)	2857(100.0)	1.00	1.00
<1 hour before labor	7(1.5)	470(98.5)	477(100.0)	0.49(0.23, 1.07)	0.40(0.16, 1.01)
1–12 hours before labor	12(12.4)	85(87.6)	97(100.0)	4.66(2.45, 8.86)	2.71(1.13, 6.53)
>12 hours before labor	7(21.9)	25(78.1)	32(100.0)	9.24(3.89, 21.97)	7.74(2.27, 26.38)
Duration of labor					
<6 hours	36(1.8)	1931(98.2)	1967(100.0)	1.00	1.00
6–12 hours	45(4.8)	885((95.2)	930(100.0)	2.73(1.75, 4.26)	1.47(0.83, 2.58)
>12 hours	29(5.1)	537(94.9)	566(100.0)	2.90(1.76, 4.78)	0.84(0.41, 1.72)
Complication during labor					
No	40(1.5)	2645(98.5)	2685(100.0)	1.00	1.00
Yes	70(9.0)	708(91.0)	778(100.0)	6.54(4.40, 9.73)	6.77(3.82, 12.00)
Types of birth					
Singleton	94(2.8)	3293(97.2)	3387(100.0)	1.00	1.00
Twins	16(21.1)	60(78.9)	76(100.0)	9.34(5.19, 16.83)	8.21(3.46, 19.47)
Sex of neonate					
Male	69(3.9)	1710(96.1)	1779(100.0)	1.00	1.00
Female	41(2.4)	1643(97.6)	1684(100.0)	0.62(0.42, 0.92)	0.77(0.48, 1.24)
Size of neonate at birth					
Small	41(5.3)	736(94.7)	777(100.0)	3.37(2.16, 5.25)	1.95(1.11, 3.42)
Average	40(1.6)	2419(98.4)	2459(100.0)	1.00	1.00
Big	29(12.8)	198(87.2)	227(100.0)	8.86(5.38, 14.60)	10.73(5.65, 20.37)
Neonatal care practice					
Good	19(1.0)	1806(99.0)	1825(100.0)	1.00	1.00
Poor	91(5.6)	1547(94.4)	1638(100.0)	5.59(3.39, 9.17)	10.36(5.13, 20.94)

NA = Not Applicable.

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during neonatal period as compared to those who received good comprehensive neonatal care.

These findings are consistent with other previous studies conducted in the country and abroad in which the intra-partum and neonatal conditions were found to be the important predictors of neonatal mortality [14,15,17,18,19,22]. This may be explained by the fact that premature and twin births are more likely to be under-weight and more prone to complications and infections. Similarly, long staying PROM and intra-partum complications increase the risk of infections and birth asphyxia. Thus, provision of comprehensive neonatal care including clean cord care, thermal care and appropriate feeding have the potential to avert some of these risks significantly.

In line with this, the verbal autopsy identified birth asphyxia, neonatal infections and prematurity as the major causes of neonatal mortality accounting for 93%. This is also in line with other prior studies where the three causes accounted for more than four-fifth of neonatal mortality [14,23–25]. While infection is the

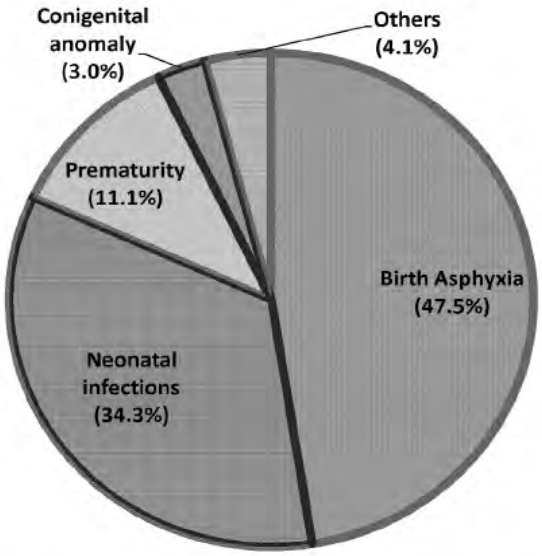

Figure 2. Causes of neonatal death, Jimma Zone, Southwest Ethiopia, Sept 2012–Dec 2013. This figure shows that birth asphyxia (47.5%), neonatal infections (34.3%) and prematurity (11.1%) were the three leading cause of neonatal death accounting for nearly 93%.
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leading cause of neonatal mortality in many studies in developing countries [23], birth asphyxia was the leading cause of death (47.5%) in this study. This finding may be explained by the high proportion of home deliveries in the absence of skilled attendants. Knowledge and skill deficiencies in prevention, diagnosis and management by unskilled attendants might have contributed to perinatal complications associated with neonatal asphyxia in these communities. The association between elevated neonatal mortality and home deliveries by unskilled attendants highlights the importance of delivery care education to local service providers.

As a programmatic implication, this study pointed out that targeting individual level factors like intra-partum conditions and the immediate neonatal period can significantly improve neonatal survival. Moreover, targeting the three major causes of death (birth asphyxia, neonatal infections and prematurity) can avert more than nine in ten of neonatal deaths.

This study may have its own limitation in that some of the medical terms were difficult to translate exactly to local languages, which might have affected the respondents' understanding. To reduce this limitation, local language experts translated the instruments. In addition, local data collectors who were fluent in local languages and familiar with local terms collected the data. The verbal autopsy was based on mothers' report of signs and symptoms concerning the underlying causes of neonatal death. This may not be as specific as the clinical diagnosis in identifying the exact cause of death. Therefore, future researches need to consider additional clinical and laboratory-based identification of causes of neonatal death by including facility based data for better interventions. In addition, the verbal autopsies were conducted within 15–30 days of neonatal death which might lead to recall bias of the exact conditions of death of the neonates. To address this, standardized and validated questionnaire was adapted in order that the mothers remember the conditions and report more valid data.

Conclusions

This study revealed that the status of neonatal mortality in the study area is still high. The great majority of neonatal deaths occurred in the first week of life. Higher-level variables were found to be less important in determining neonatal mortality. Lower (individual) level variables were found to be important determinants of neonatal mortality. Birth order, ANC visits, place of delivery, prematurity, PROM, complication during labor, twin births, size of neonate at birth and neonatal care practices were identified as determinants of neonatal mortality. Birth asphyxia, neonatal infections and prematurity were identified as the leading causes of neonatal mortality accounting for more than 90%. Ensuring the continuum of care from pregnancy through delivery to the immediate postnatal period should be in place so as to address neonatal mortality in the study area. Specifically, increasing adequate ANC visits and health facility delivery by addressing the first and second delays are very crucial. Provision of comprehensive neonatal care such as cord care, thermal care and early initiation of breast-feeding are recommended.

Supporting Information

Figure S1 Schematic presentation of sampling method. This figure shows the multistage clustered sampling methods based the proportional allocation to the size of the population.
(TIF)

Table S1 Parameter coefficients and test of goodness-of-fit of the mixed effect multilevel model, in Jimma Zone, Southwest Ethiopia, September 2012-December 2013. This table shows the parameter estimates of the multilevel logistic regression, including the fixed effects, random effect at level 2, the Infraclass correlation Coefficient, LR test and level of significance both in the empty-model and full model.
(DOCX)

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Author Contributions

Conceived and designed the experiments: GTD MFA AWY. Performed the experiments: GTD MFA AWY. Analyzed the data: GTD MFA AWY. Contributed reagents/materials/analysis tools: GTD MFA AWY. Wrote the paper: GTD MFA AWY. Read the final manuscript and approved for submission: GTD MFA AWY.

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Annex 2: Data Collection Tools

Annex 2.1. Census format to enumerate pregnant women

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH

Informed consent for respondents providing information during census to identify pregnant women
Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet

Introduction:
Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are visiting all households in the selected kebeles of Jimma Zone to identify pregnant women for the study entitled ***"Birth Preparedness, complication readiness, neonatal care practices and their effect on neonatal health status in Jimma, Southwest Ethiopia."***

Purpose of the research
The purpose of this visit is simply to identify and register pregnant women who will potential be the participants of the study.

Procedures
We are visiting all the households from the selected 73 Kebels selected by chance for the study. It may take about 5 minuets of your time to speak to me and tell me the list of all female 15-49 years of age and some very few related questions.

Risks and discomfort
I may ask you about marital status and pregnancy status of the women, which may be personal information and may not be comfortable. But, as the study is to improve maternal and child health in the study area, you may fell free and tell me the information.

Benefits
There will be no direct benefit to you, but based on the information you provide us, we will conduct study that intends to address maternal and neonatal health problems occurring during pregnancy, child birth and after birth.

Confidentiality
The information you will give me will be kept confidential. The names you will provide me will be replaced with some codes and we will not communicate to someone else. No any names will be included during the interview and the data to be collected will also be used in aggregated form.

Right to refuse or withdraw
You can refuse or stop to answer any question to which you are not comfortable. However, your genuine information will have paramount importance in improving maternal health services in future.

Are you willing to provide me the information: 1. Yes☐ tick and proceed 2. No☐ tick and Stop

Census conductor (enumerator): Name _____, sig. _____, Date _____

Supervisor: Name _____, sig. _____, Date _____

I-General background

1. Woreda: _____
2. Kebele: _____
3. Got: _____
4. Garee: _____
5. Name of head of the household _____
6. House number _____

I- List of all 15-49 years old women and their pregnancy information

S/N	List of 15-49 years old female	Age in years	Relation to Head of household	Marital status /cohabitation	Current Pregnancy status*	Approx. GA in weeks	Language preference	Pregnant woman's ID.NO (Code)	Remarks
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Keys to options for the questions

1. Relation to the head of household: 1. Wife 2. Daughter 3. Other relative 4. Servant 5. Other (write in words)
2. Marital status: 1. Married 2. Single 3. Divorced 4. Widowed
3. Pregnancy status: 1. Pregnant 2. Not pregnant (***Use the attached pregnancy screening criteria)**
4. GA in weeks: write approximate weeks of pregnancy for pregnant women
5. Language preference: 1. Afan Oromoo 2. Amharic
6. The woman's Code (ID. NO.) will be given latter at office by the PI.

Pregnancy screening checklist (Adapted from Stanback et al, 1999)

Ask this pregnancy screening criteria and indicate eligibility for all women 15-49 years, who is assumed to have started sexual experiences.

S/N	Criteria	Responses	Eligibility
1	Are you known pregnant? (Confirmed at health facility or big abdomen with visible pregnancy)	**Yes**	**Eligible**
		No	**Go to → 2**
2	Have you had a baby in the last 4 weeks?	**Yes**	**Non-Eligible**
		No	**Go to → 3**
3	Are you exclusively or almost exclusively breastfeeding a baby < 6 months old and have you had no menstrual period since giving birth?	**Yes**	**Non-Eligible**
		No	**Go to → 4**
4	Have you had a miscarriage or abortion in the past 7 days?	**Yes**	**Non-Eligible**
		No	**Go to → 5**
5	Have you been using a reliable contraceptive method consistently and correctly since last menstrual period or giving birth?	**Yes**	**Non-Eligible**
		No	**Go to → 6**
6	Did your last menstrual period start within the past 7 days?	**Yes**	**Non-Eligible**
		No	**Go to → 7**
7	Did your last menstrual period start within the past 12 weeks?	**Yes**	**Non-Eligible***
		No	**Go to → 8**
8	Have you abstained from sexual intercourse since your last menstrual period or delivery?	**Yes**	**Non-Eligible**
		No	**Eligible**

**There may be little chance of having early pregnancy, but not eligible for the study.*

Annex 2.2. Baseline survey questionnaire

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Informed consent for respondents participating in the survey entitled –Birth Preparedness and complication readiness and affecting factors among pregnant women in Jimma Zone, Southwest Ethiopia."

Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet

Introduction

Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are speaking with pregnant women and their families about the experience of being pregnant and of having children in Jimma Zone.

Purpose of the research

A number of problems can occur and endanger the life of mothers during pregnancy and child birth. To deal with these problems, birth preparedness and complication readiness has been an effective intervention. However, its status and determinate factors haven't been well assessed. Therefore, this study is aimed to fill this gap by conducting community based survey in Jimma Zone.

Procedures

You are among the 3604 pregnant women selected by chance for this study. I will ask you few questions concerning some personal, socio-demographic and economic information. I will also ask you information regarding the plan you have for the birth of this pregnancy. The interview will take about 30 minutes. So, I request your volunteer participation.

Risks and discomfort

There might be slight discomfort to share some personal information. However, we do not wish this to happen and you may refuse to answer any of the questions if you feel uncomfortable.

Benefits

There will be no direct benefit to you, but based on the information you provide us, we will design strategies to improve the interventions targeted to birth preparedness and complication readiness so as to prevent maternal health problems occurring during pregnancy and child birth.

Confidentiality

The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw

You can refuse to answer any question to which you are not comfortable. You may stop participating in the interview at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving maternal health services in future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participant

Signature/finger print _____ date _____
(Proceed with the interview)

No ☐ **(Terminate the interview)**

Signature of the interviewer

Name _____ Signature _____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note:

In case of any unclearity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

WOMAN CODE_____

Section-1: Socio-demographic Information

Q#	Question	Response category	Go to Q.
101	Woreda	_____	
102	*Kebele*	_____	
103	Residence	1. Urban 2. Rural	If urban→Q106
104	If the response to Q103 is rural, Gote	_____	
105	If the response to Q103 is rural, Gare	_____	
106	Name of head of House hold	_____	
107	How old are you now?	_____ years	
108	What is your ethnicity?	1. Oromo 2. Yem 3. Dawuro 4. Kaficho 5. Amhara 6. Other (Specify)	
109	What is your religion?	1. Islam 2. Orthodox Christian 3. Protestant 4. Catholic 5. Jova 6. Traditional 7. Other (specify) _____	
110	What is your marital status now?	1. Single 2. Married/in Union 3. Divorced 4. Widowed 5. Separated	
111	Have you ever attended school?	1. Yes 2. No	If No →Q113
112	If yes to Q111, what is the highest Grade you have completed?	1. Grade 1-4 2. Grade 5-8 3. Grade 9-10 4. Grade 11-12 5. Grade 12+	
113	What is your current occupation?	1. House wife/farmer 2. Government employee 3. Private employee 4. NGO employee 5. Merchant 6. Student 7. Other Specify _____	
114	In addition to your house work, do you do any other work for which you are paid in cash or in kind?	1. Yes 2. No	If No skip to **→Q116**
115	If yes to Q014, how much birr is paid for you per month?	_____ (ET. Birr)	

Q#	Question	Response category	Go to Q.
116	What is current occupation of your husband?	1. Farmer 2. Government employee 3. Private employee 4. NGO employee 5. Merchant 6. Student 7. Other Specify	If currently not in marital union, skip →**Q116 and Q117**
117	What is approximate monthly income of your husband per month?	_____ (ET. Birr)	
118	What is the main source of drinking water for members of your household	1. Pipe water 2. Public hand pump 3. Public tap/standpipe (_Bono‘) 4. Protected dug well 5. Unprotected dug well 6. Protected spring 7. Unprotected spring 8. Rain water	
119	What kind of toilet facility do you have that your household members use?	1. Flush toilet 2. Traditional Pit toilet/latrine 3. Ventilated Improved Pit (VIP) latrine 4. No facility-use open field 5. Other (specify) _____	
120	How is your residential home ownership?	1. Own home 2. Rented home 3. Other (specify) _____	
121	How many rooms/classes does your household have	_____ rooms	
122	How many rooms in this household are used for sleeping	_____ rooms	
123	Do you have a separate room which is used as a kitchen?	1. Yes 2. No	
124	What is the main material of the floor of the home? (RECORD BY OBSERVING)	1. Natural floor- earth 2. Natural floor-dung 3. Rudimentary floor with wood/bamboo 4. Finished floor with Cement 5. Other (specify) _____	
125	What is the main material of the roof of the home? (RECORD BY OBSERVING)	1. Thatched 2. Corrugated iron sheet 3. Other (specify) _____	

Q#	Question	Response category	Go to Q.
126	What is the main material of the wall of the home? (RECORD BY OBSERVING)	1. No wall 2. Wood without mud 3. Wood with mud 4. Wood with cement covered 5. Cement blocks or Bricks 6. Other (specify) _____	
127	What type of fuel do you mainly use for cooking in your household?	1. Electricity 2. Natural gas 3. Biogas 4. Kerosene 5. Charcoal 6. Firewood 7. Dung 8. Other (specify) _____	
128	Does your household own the following?		
	Electricity?	1. Yes 2. No	
	Radio?	1. Yes 2. No	
	Television?	1. Yes 2. No	
	A landline telephone functioning?	1. Yes 2. No	
	Refrigerator	1. Yes 2. No	
129	Does any member of your household own the following?		
	Watch?	1. Yes 2. No	
	Mobile phone?	1. Yes 2. No	
	Bicycle?	1. Yes 2. No	
	Motor cycle?	1. Yes 2. No	
	Animal drawn cart?	1. Yes 2. No	
	A car or truck	1. Yes 2. No	
130	Does any member of this household own any agricultural land?	1. Yes 2. No	If no→Q132
131	If Yes to Q030, how many hectares?	_____hectares	
132	Does this household own any livestock, herds, other farm animals, or poultry?	1. Yes 2. No	If no→Q134
133	If yes to Q032, how many:		
	Cattle?	_____	If none enter 0 (zero)
	Milk cows or bulls?	_____	
	Horses, donkeys or mules?	_____	
	Goats?	_____	
	Sheep?	_____	
	Chickens?	_____	

Section-2: Past obstetric history

Q#	Question	Response category	Go to Q.
201	How many pregnancies have you ever had, including current pregnancy, abortion and stillbirth?	_____	If this is her 1st pregnancy, skip to →**Q301**
202	Did any of these pregnancies ended in abortion (termination of pregnancy before 28 weeks of gestation)?	1. Yes 2. No	If No, skip to →Q204
203	If Yes to Q202, how many of them ended in abortion?	_____times	
204	Did any of these pregnancies ended in stillbirth (delivery ended in birth of dead foetus after 28 weeks of gestation)?	1. Yes 2. No	If No, skip to →Q206
205	If Yes to Q204, how many of them ended in still birth?	_____times	
206	How many of them ended in live birth (a newborn that showed any signs or life)?		
207	**ADD THE RESPONSES TO Q203,Q205 and Q206 AND COMPARE WITH Q034 AND RECONCIDE IF DISCRIPANCIES**		
208	**What is the time Interval between this and the previous pregnancy?**	_____ months	
209	Had you attended ANC for your last delivery (for the pregnancy before this pregnancy)	1. Yes 2. No	If No, skip to Q213
210	If Yes to Q209, at what gestation did you have first visit?	1. 1st trimester 2. 2nd trimester 3. 3rd trimester	
211	If Yes to Q209, how many visits did you have?	1.Only Once 2. Only Twice 3. Only three times 4. Four and above	
212	If Yes to Q209, where did you attend?	1. Hospital 2. Health centre 3. Health post 4. Home 5. other (specify) ____	
213	Where did you give your last delivery?	1. Hospital 2. Health centre 3. Health post 4. Home 5. other (specify) ____	
214	Who attended your last delivery?	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. HEWs 6. TBA/TTBA 7. family member 8. Other (specify) ____	

Section-3: Knowledge of danger signs

Q#	Question	Response category
301	In your opinion, can unforeseen problems related to pregnancy or child birth occur that could endanger the life of a woman?	1. Yes 2. No 3. I don‘t know
302	In your opinion, what are some serious health problems that can occur **during pregnancy** that could endanger the life of a pregnant woman? PROBE: Any others?	1. Bleeding 2. Severe headache 3. Blurred vision 4. Convulsions 5. Swollen hands/face 6. High fever 7. Loss of consciousness 8. Difficulty breathing 9. Sever weakness 10. Severe abdominal pain 11. Accelerated/reduced foetal mov‘t 12. Water breaks without labour (PROM) 13. Other Specify _____ 14. **Don’t know any**
303	In your opinion, what are some serious health problems that can occur **during labour and child birth** that could endanger the life of the woman? PROBE: Any others?	1. Severe Bleeding 2. Severe headache 3. Blurred vision 4. Convulsions 5. Labour lasting >12 hours 6. High fever 7. Loss of consciousness 8. Placenta not delivered 30 minutes after baby 9. Other Specify _____ 10. **Don’t know any**
304	In your opinion, what are some serious health problems that can occur **during the first 2 days after birth** that could endanger the life of the woman? PROBE: Any others?	1. Severe Bleeding 2. Severe headache 3. Blurred vision 4. Convulsions 5. Swollen hands/face 6. High fever 7. Loss of consciousness 8. Difficulty breathing 9. Sever weakness 10. Malodorous vaginal discharge 11. Other Specify _____ 12. **Don’t know any**
305	In your opinion, what are some serious health problems that can occur **during the first 7 days after birth** that could endanger the life of a newborn baby? PROBE: Any others?	1. Difficult or fast breathing 2. Yellow skin colour (Jaundice) 3. Poor sucking/feeding 4. Pus, bleeding or discharge around umbilical cord 5. Baby very small 6. skin lesion or blisters 7. Convulsions/spasms/rigidity 8. Lethargy/unconscious 9. Red or swollen eyes with pus 10.Other Specify _____ 11. **Don’t know any**

Section-4: Knowledge of community resources

Q#	Question	Response category
401	Have you ever heard the term ―Birth preparedness"?	1. Yes 2. No
402	In your opinion, what are some things a woman can do to prepare for birth? PROBE: more than one answer is possible so ask as ‗any others? until she says no more.	1. Identify mode of transport 2. Save money 3. Identify blood donor 4. Identify place of delivery 5. Identify skilled provider 6. Identify who accompanies 7. Identify decision maker 8. Arrange materials for clean home delivery (rather blade, thread, close etc…) 9. Others (list) _____ _____ _____ _____ 10. Don't know any
403	Does your community provide services to assist women in preparing for birth? For instance:	
	1. Are there transportation services for woman?	1. Yes 2. No 3. I Don't know
	2. Are there ways to get money to help families pay for birth?	1. Yes 2. No 3. I Don't know
	3. Are there ways to get blood donated during pregnancy or complications?	1. Yes 2. No 3. I Don't know
	PROBE: Any other services you know available to help Pregnant women during birth in your community? _____ _____ _____ _____	
404	Which one of the above have you/your family planed to arrange?	
	1. Have you/your family planned to arrange transportation services for this birth?	1. Yes 2. No
	2. Have you/your family planed to save money to help you for during this birth?	1. Yes 2. No
	3. Have you/your family planed to arrange ways to get blood donation during pregnancy or complications of this birth?	1. Yes 2. No

Section-5: Plan to use obstetric services

Q#	Question	Response category	Go to Q.
501	Please can you tell me your last LNMP (Last Normal menstrual period)? RECORD THE DATE, at least approximate	__ __/__ __/__ __ __ __	
502	How many weeks pregnant are you now? RECORD NUMBER OF COMPLETED WEEKS. If told in months, convert to weeks and record in weeks.	_____ Weeks	
503	USE DATE OF INTERVIEW and Calculate GA and reconcile with Q057.	_____weeks	
504	Did you have any Antenatal care during this pregnancy?	1. Yes 2. No	If No, skip to **Q509**
505	If Yes to Q504, where was the place for ANC?	1. Hospital 2. Health centre 3. Health Post 4. Home of TBA/TTBA 5. Home of the respondent 6. other (Specify)_____	
506	If Yes to Q504, How many times in total did you receive ANC for this pregnancy till today?	_____ times	
507	If Yes to Q504, whom do you see for the ANC?	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. Health Extension Worker 6. TBA/TTBA 7. Family Member 8. Other (specify) _____	
508	If Yes to Q504, at what weeks of Gestation did you have the first care/Visit?	_____weeks	
509	If Yes to Q504, how many ANC Visits have you planned to attend at all? (including the attended and future plan)	1. Planed not to attend at all 2. Once only 3. Twice only 4. Three times only 5. Four times and above 6. Any other response (Specify)_____	
510	Have you planed on the place where to give this birth?	1. Yes 2. No	If No, skip to **Q513**
511	If Yes to Q064, where have you planed to deliver?	1. Hospital 2. Health Centre 3. Health Post 4. TBA/TTBA‘s home 5. Home (respondent‘s) 6. Other (specify) _____	
512	Why did you prefer this place for your plan? PROB: Any other reasons?	_____ _____	

Q#	Question	Response category	Go to Q.
513	Have you planned by whom to be attended for the delivery of this pregnancy?	1. Yes 2. No	If No skip to Q601
514	If Yes to Q513, by whom did you plan to be attended?	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. Health extension worker 6. TBA/TTBA 7. Family Members	
515	Why did you prefer this attendant for your plan? PROB: Any other reasons?	_____ _____	

Section 6: Attitudes and Perceptions about BP and CR

These are question related to attitude and perception towards BP and CR. There is no right or wrong answerer for the questions. So, when I read the statement you will respond me your level of agreement from the given five options.

(1= STRONGLY DISAGREE (**SD**), 2 = DISAGREE (**D**), 3=INDIFFERENT (**ID)**, 4 = AGREE (**A**), **5** = STRONGLY AGREE (**SA**))

TICK BY PUTTING **"√"** FOR APPROPRIATE RESPONSE

Q.#	Questions	Response Codes				
		SD (1)	D (2)	ID (3)	A (4)	SA (5)
601	A woman should plan ahead of time where she will give birth to her baby.					
602	A woman should plan ahead of how she will get to the place where she will give birth.					
603	It is necessary for a husband/partner to accompany his wife to ANC visits.					
604	It is necessary for a husband/partner to accompany his wife when she is giving birth.					
605	Giving birth is mostly a woman's matter. Husbands/partners have nothing to contribute.					
606	When women do not go to a health facility to give birth, it is mainly because it is too expensive.					
607	When women do not go to a health facility to give birth, it is mainly because the staff there do not treat women respectfully.					
608	When women do not go to a health facility to give birth, it is mainly because it is too difficult to get there.					

I have completed my Interview. Thank you for your cooperation!

Annex 2.3. Baseline in-depth interview guide

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Informed consent for In-depth Interview of Key informants for the study entitled *"Birth Preparedness and complication readiness and affecting factors among pregnant women in Jimma Zone, Southwest Ethiopia."*

Key informants: Husband/family members, TBA and HEWs
Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet
Introduction:
Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are conducting in-depth interview with individuals who are selected purposively based on their experience and rich source of information concerning birth preparedness and complication readiness in this community.

Purpose of the research
The purpose of the study is to assess the status of birth preparedness and complication readiness in Jimma Zone. And the findings of the study will be used to plan interventions to improve birth preparedness and complication readiness in the future.

Procedures
You are among the 12 key informants selected purposively for this in-depth interview. I will ask you few questions concerning the preparation being made for birth and its complication and affecting factors in this community. The interview will take about 1:00 hour. So, I request your volunteer participation.

Risks and discomfort
The interview may take some of your time. However, we try to make it short and to the point and guide you through the interview.

Benefits
There will be no direct benefit to you, but based on the information you provide us, we will design strategies to improve the interventions targeted to birth preparedness and complication readiness so as to prevent maternal health problems occurring during pregnancy and child birth.

Confidentiality
The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw
You can refuse to answer any question to which you are not comfortable. You may stop participating in the interview at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving maternal health services in future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participant

Signature/finger print _____ date _____
(Proceed with the interview)

No ☐ **(Terminate the interview)**

Signature of the interviewer

Name _____ Signature _____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note:

In case of any unclearity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

Respondents back ground

1. Category of participant: 1. Husband/family 2. TBA 3. HEW
2. Sex _____, age _____, Educational status _____,

Interview Guide questions

1. What health problems do you think a woman can face during pregnancy, delivery and after birth?
    - 1.1. While pregnant?
    - 1.2. During labour and delivery?
    - 1.3. After deliver with in the first 6 weeks?
2. Have you ever heard the term danger signs during pregnancy, delivery and after birth ? If so, do you explain them?
3. What things do you think can be done to prevent these health problems?
    - 3.1. By the woman? 3.2. By her family?
    - 3.3. By the community? 3.4. By health facility?
4. Have you ever heard the term birth preparedness and complication readiness? If so would you explain?
5. What are the things usually done in this community to prepare a pregnant women for child birth?
    - 6.1. By the woman? 6.2. By her family? 6.3. By the community?
6. How do you see the ANC use by pregnant mothers in this community?
    - 6.1. Do the majority use? When do they start? How frequent?
    - 6.2. What are the major barriers to ANC use in this community?
7. How do you see the delivery service use by pregnant women?
    - 7.1. Where do most of the pregnant women give birth in this community? Why they prefer this?
    - 7.2. Do the majority go to health facility for delivery?
    - 7.3. What are the major barriers for not using health facility for delivery in this community?
8. What options are available to save money to be used during delivery in this community?
9. What transportation options are available to be used during labour of pregnant women?
10. Is there any mechanism to get blood donor during delivery in case it is needed?
11. If you have any additional point that is important in improving birth preparedness and complication readiness?

I have completed my interview thank you very much!

Annex 2.4. Baseline FGD guide

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Informed consent for FGD Participants for the study entitled *"Birth Preparedness and complication readiness and affecting factors among pregnant women in Jimma Zone, Southwest Ethiopia."*

Participants: 8-10 Pregnant women
Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet
Introduction:
Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are conducting focus group discussions with pregnant women who are selected purposively based on their experience and rich source of information concerning birth preparedness and complication readiness in this community.

Purpose of the research
The purpose of the study is to assess the status of birth preparedness and complication readiness in Jimma Zone. And the findings of the study will be used to plan interventions to improve birth preparedness and complication readiness in the future.

Procedures
You are selected purposively for this Focus group discussion like the other group of pregnant women. I will raise few questions concerning the preparation being made for birth and its complication and affecting factors in this community so that you can discuss on them. The discussion will take about 1:00 hour. So, I request your volunteer participation.

Risks and discomfort
The discussion may take some of your time. However, we try to make it short and to the point and guide you through the interview.

Benefits
There will be no direct benefit to you, but based on the information you provide us, we will design strategies to improve the interventions targeted to birth preparedness and complication readiness so as to prevent maternal health problems occurring during pregnancy and child birth.

Confidentiality
The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw
You can refuse to answer any question to which you are not comfortable. You may stop participating in the discussion at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving maternal health services in future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the discussion at any time without in anyway affecting my right.

Signature/finger print of the participants

1. Signature/finger print _____ date _____
2. Signature/finger print _____ date _____
3. Signature/finger print _____ date _____
4. Signature/finger print _____ date _____
5. Signature/finger print _____ date _____
6. Signature/finger print _____ date _____.
7. Signature/finger print _____ date _____
8. Signature/finger print _____ date _____.
9. Signature/finger print _____ date _____
10. Signature/finger print _____ date _____

(Proceed with the interview)

No ☐ **(Terminate the interview)**

Signature of the Moderator : Name _____, Signature_____ date _____

Signature of the Note taker: Name _____, Signature_____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note: In case of any unclearity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

I-Participants back ground

(Don‘t write their name, code as P1, p2, p3….p12 under the column headed discussant code)

S/N	Discussant code	Age	Educational background	Gravidity	Parity	Gestation age (Months)

II-Discussion Guides

1. What health problems do you think a woman can face during pregnancy, delivery and after birth?
    1.1. While pregnant?
    1.2. During labour and delivery?
    1.3. After deliver with in the first 6 weeks?
2. What things do you think can be done to prevent these health problems?
    2.1. By the woman?
    2.2. By her family?
    2.3. By the community?
    2.4. By health facility?
3. What are the things usually done in this community to prepare a pregnant women for child birth?
    3.1. By the woman?
    3.2. By her family?
    3.3. By the community?
4. What are the major barriers to ANC use in this community?
5. What are the major barriers for not using health facility for delivery in this community?
6. What options are available to save money to be used during delivery in this community?
7. What transportation options are available to be used during labour of pregnant women?
8. What are the mechanisms to get blood donor during delivery in case it is needed?

I have completed my point of discussion thank you very much!

Annex 2.5. Follow up survey questionnaire

ADDIS ABABA UNIVERSITY
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SCHOOL OF PUBLIC HEALTH

Informed consent for respondents participating in the survey entitled *"The status of skilled care use, neonatal care and associated factors in Jimma Zone, Southwest Ethiopia."*

Investigators: ***Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku***

Part I – Information sheet

Introduction:

Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. As you remember, we have collected information from you while you were pregnant regarding your pregnancy and preparation for birth. Now, we are speaking with all women who were included in this study during their pregnancy and currently have infants of 4-6 weeks of age.

Purpose of the research

Neonatal period is a time when the greatest share of infant illness and mortality takes place. To avert these, the WHO has developed the minimum neonatal care packages during pregnancy, delivery and postpartum periods. However, the current situation of neonatal care practices, neonatal illness and treatment seeking behaviour of mothers and influencing factors are not well known in Jimma Zone. Therefore, this study is aimed to fill this gap by conducting community based survey. The results of this survey will be used to help improve health programs for women.

Procedures:

As we told you during the previous interview, you have been selected for the interview by means of a random or chance selection process like the other 3604 pregnant women who were selected for the interview by means of a random or chance selection process. I will ask you few questions concerning some neonatal care practices, neonatal illnesses and treatment seeking behaviours.. The interview will take about 30 minutes. So, I request your volunteer participation.

Risks and discomfort:

There might be slight discomfort to share some personal information. However, we do not wish this to happen and you may refuse to answer any of the questions if you feel uncomfortable.

Benefits

There will be no direct benefit to you while participating in this study; but based on the genuine information you provide us, we will design strategies to improve neonatal care services, reduce neonatal illness and treatment seeking behaviour of mothers so as to reduce neonatal mortality in Jimma Zone

Confidentiality

The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw

You can refuse to answer any question to which you are not comfortable. You have also the right to stop participating in the interview at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving neonatal health in the future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐ (tick and proceeded) No ☐ (tick and terminate the interview)

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participant

Signature/finger print _____ date _____
(Proceed with the interview)

Signature of the interviewer

Name _____ Signature _____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note:

In case of any unclarity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

WOMAN CODE_____

Section –VII: Background information

Q#	Question	Response category
701	Woreda	
702	*Kebele*	
703	Residence	1. Urban→Q706 2. Rural
704	If the response to Q003 is rural, Gote	
705	If the response to Q003 is rural, Gare	
706	Name of head of House hold	
707	Name of the neonate	
708	Age of the neonate	_____days
709	Birth type	1. Singleton 2. Multiple (twins)
710	Sex of the neonate	1. Male 2. Female
711	What was the outcome of the last pregnancy?	1. Live birth and alive now 2. Aborted (pregnancy terminated before 28 weeks of gestation) →**END** 3. Still birth (ended in dead foetus after 28 weeks of GA) →**END** 4. Born alive and died within 28 days of age →**END AND APPOINT FOR VA**
712	How long it will take to reach health post from your residential home?	On foot _____minutes By car _____ munities (if any)
713	How long it will take to reach Health centre from your residential home?	On foot _____minutes By car _____ munities (if any)
714	How long it will take to reach hospital from your residential home?	On foot _____minutes By car _____ munities (if any)

Section-VIII: Use of Obstetric Services

Q#	Question	Response category
801	Did you see anyone for Antenatal care during the pregnancy of this infant?	1. Yes 2. No→Q901
802	If Yes to Q801, How many ANC Visits did you made?	_____ Visits
803	If Yes to Q801, where was the place for ANC?	1. Hospital 4. Home of TBA/TTBA 2. Health centre 5. Home 3. Health Post 6. Other (specify) ____
804	If Yes to Q801, whom do you see for the ANC?	1. Doctor 5. HEW 2. Nurse 6. TBA/TTBA 3. Midwife 7. Family Member 4. Health Officer 8. Other specify ____
805	If Yes to Q801, at what weeks of Gestation did you have the first ANC ?	_____weeks
806	If yes to Q801, did you receive any dose of TT?	1. Yes 2. No
807	If Yes to Q801, How may doses of TT did you receive?	_____ times
808	If Yes to Q801, Did you receive any advice on self care during ANC Visits of this pregnancy?	1. Yes 2. No
809	If Yes to Q801, Did you receive any advice on neonatal nutrition during ANC Visits of this pregnancy?	1. Yes 2. No
810	If Yes to Q801, Did you receive any advice on breast feeding during ANC Visits of this pregnancy?	1. Yes 2. No
811	If Yes to Q801, Did you receive any advice on infant immunization?	1. Yes 2. No

Section-IX: Neonatal care during labour and delivery

Q.#	Question	Response code
901	Where was t he place of delivery of this infant?	1. Hospital 2. Health centre 3. Health Post 4. Home of TBA/TTBA 5. Home of the respondent 6. other (Specify) _____
902	Why did you prefer this place?	_____ _____ _____ _____
903	What was the mode of delivery	1. Normal Vaginal delivery 2. Operative delivery (C/S) 3. Assisted delivery by Vacuum or Forceps 4. Other (specify) _____
904	Who attended the delivery	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. Health Extension Worker 6. TBA/TTBA 7. Family Member 8. Other (specify) _____
905	Why did you prefer this person?	_____ _____
906	If the delivery was in health facility (hospital, health centre or health post) who accompanied you to give social support during delivery?	1. No one accompanied 2. Husband 3. Mother 4. Mother- in-Law 5. Other family member 6. Other (Specify) _____
907	If the delivery was not at health facility (at home, TTBA/TBA's Home) who accompanied you to give social support during delivery?	1. No one accompanied 2. Husband 3. Mother 4. Mother- in-Law 5. Other family member 6. Other (Specify) _____
908	How long was the duration of labour (from start to expulsion of placenta)?	1. <6 hours 2. 6-12 hours 3. >12 hours
909	How do you rate the size of the neonate at the time of birth? (READ THE OPTIONS)	1. Very Small 2. Smaller than usual 3. about average 4. Larger than usual
910	What is the approximate GA (duration of pregnancy) in weeks? (If told in month convert to weeks by using 1 month = 4 weeks)	_____weeks
911	Was the late part of the pregnancy, labour or delivery had any complications?	1. Yes 2. No
912	If Yes to Q911, What complication(s) was occurred? (multiple responses are possible)	1. Mother had convulsions 2. Newborn delivered feet first 3. Excessive bleeding 4. Emergency operative delivery (C/S) 5. Multiple birth (twins) 6. Other (Specify) _____
913	Did the water (amniotic fluid membrane) break before labour or during labour	1. Before labour 2. During labour
914	If break before labour, how much time before the onset of labour?	1. <1hour 2. 1-12 hours 3. >12 hours but <24 hours 4. 24 hours and above
915	How much time did the labour and delivery took?	1. less than 12 hours 2. 12 hours or more

Ask Q916-922 For all deliveries conducted out of health facility		
916	After the baby was born, what instrument was used to cut the cord?	1. New or boiled rather blood 2. Old unboiled rather blood 3. Household knife 4. Other (Specify)
917	What was used to tie the cord?	1. Not tied at all 2. Clean thread 2. Unclean/old thread 3. Other (specify)
918	What was applied to the stamp of umbilical cord after cutting?	0. Nothing was applied 1. Butter 2. Cow dung 3. Ash 4. Other (specify)
919	Was the baby Wrapped immediately after delivery?	1. Yes, before the placenta came out 2. Yes, but after placenta came out 3. Not wrapped at all
920	If rapped, what was used to wrap the baby?	1. New washed cloth 2. New unwashed clothe 3. Old washed cloth 4. Old unwashed cloth 5. Other (specify)
921	Where was the baby put after it was delivered?	1. Skin-to-skin contact with mother 2. Wrapped with clean close and put in contact with mother 3. Wrapped and put in separate place, not skin –to-skin contact with mother
922	How long after birth was the baby bathed for the first time?	1. <1 hour 2. 1-6 hours 3. after 6 hours but <12 hours 4. 12-24 hours 5. >24 hours
923	What was baby fed for the first time immediately after birth?	1. Breast milk/colostrums 2. Breast milk from other woman 3. Butter was given 4. Cow‘s milk 5. Commercial formula feed (Nido, mother‘s choice) 6. Glucose water 7. Plain water 8. Honey 9. Other (specify) _____
924	How long after birth was the baby initiated breast milk?	1. Within the first 1 hour 2. After 1 hour before 6 hours 2. 6-12 hours 3. >12 hours 4. Not breast feed at all
925	What is the situation of breast feeding in the first month after 2 hours of delivery?	1. Exclusive breast feeding 2. Supplementary feeding was given in addition to breast milk 3. Only formula feeding without breast milk 4. Other (specify) _____
926	If supplementary feeding was started what was given?	1. cow milk 2. gruel made of cereals 3. Other (specify) _____

Section-X: *Postnatal care for the Newborn (from 2 hours – 28 days)*

Q.#	Question	Response code
1001	Have you made any postnatal visit to health facility to check health status of your baby?	1. Yes 2. No→Q1012
1002	If Yes to Q1001, where was the visit?	1. Hospital 2. Health Centre 3. Health post 4. Other (specify)_____
1003	If Yes to Q1001, whom did you see for the check up of your neonate during the visit?	1. Doctor 2. Nurse 3. Midwife 4. Other (specify)_____
1004	If Yes to Q1001, how many PNC visits have you had?	1.Oonly once 2. Twice 3. Three or more times
1005	If Yes to Q1001, how long after birth was the check up?	1st visit _____ days after birth 2nd visit _____ days after birth 3rd Visit _____ days after birth
1006	If Yes to Q1001, did you receive any advice on selfcare during PNC visit?	1. Yes 2. No
1007	If Yes to Q1001, did you receive any advice on neonatal nutrition during PNC visit?	1. Yes 2. No
1008	If Yes to Q1001, did you receive any advice on breast feeding during PNC visit?	1. Yes 2. No
1009	If Yes to Q1001, did you receive any advice on infant immunization during PNC visit??	1. Yes 2. No
1010	Did the newborn receive any immunization on the day of birth?	1. Yes 2. No
1011	If yes to Q1010, which vaccine? (multiple responses are possible)	1.Polio-0 2. BCG 3. Other (specify) _____
1012	Was any vaccine given after first day of delivery for the neonate?	1. Yes 2. No
1013	If yes Q1012, what vaccine when?	Vaccine days after birth _____ _____ _____ _____ _____ _____ _____ _____
1014	How often does the neonate sleep under the bed net to prevent from Malaria?	1. Not at all 2. Sometimes 3. Always
1015	Was the neonate slept under the bed net the night before the survey?	1. Yes 2. No
1016	Does the bed net hang over the bed during the data collection time? (COMPLETE BY OBSERVING)	1. Yes 2. No

I have completed the interview. Thank you for your cooperation!

Annex 2.6. Verbal autopsy (VA) questionnaire

ADDIS ABABA UNIVERSITY
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Informed Consent form for respondent of Verbal Autopsy to identify causes of neonatal mortality

Investigators: ***Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku***

Part I – Information sheet

Introduction:

Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. As you remember, we have collected information from you while you were pregnant regarding your pregnancy and preparation for birth. Now, we are speaking with all women who were included in this study during their pregnancy and whose neonates were died. We are collecting information regarding the cause of neonatal death for future interventions.

Purpose of the research

Identifying the cause of neonatal death is very important for intervention purpose in order to insure infant survival. However, we have no enough studies in Jimma Zone. Therefore, this study is aimed to fill this gap by conducting community based Verbal Autopsy. The results of this survey will be used to design appropriate interventions targeted in reduction of neonatal mortality.

Procedures

As we told you during the previous interview, you have been selected for the interview by means of a random or chance selection process like the other 3604 pregnant women who were selected for the interview. In addition, you were included in this interview like all the others whose neonates died. I will ask you few questions concerning the conditions of the death of last neonate. The interview will take about 30 minutes. So, I request your volunteer participation.

Risks and discomfort

There might be slight discomfort to share some personal information regarding the death of the neonate and may feel grief. However, we do not wish this to happen and you may refuse to answer any of the questions if you feel uncomfortable.

Benefits

There will be no direct benefit to you while participating in this study; but based on the genuine information you provide us, we will design strategies to improve services to deal with causes of neonatal death in the future.

Confidentiality

The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw

You can refuse to answer any question to which you are not comfortable. You have also the right to stop participating in the interview at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving neonatal health in the future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐ (tick and proceeded) No ☐ (tick and terminate the interview**)**

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participant

Signature/finger print _____ date _____
(Proceed with the interview)

Signature of the interviewer

Name _____ Signature _____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note:

In case of any unclarity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

WOMAN CODE_____

Section –VII: Background information

Q#	Question	Response category
701	Woreda	
702	*Kebele*	
703	Residence	1. Urban→Q706 2. Rural
704	If the response to Q003 is rural, Gote	
705	If the response to Q003 is rural, Gare	
706	Name of head of House hold	
707	Name of the deceased neonate	
708.1	Date of birth of the deceased neonate	__ __/__ __/__ __ __ __
708.2	Date of death of the deceased neonate	__ __/__ __/__ __ __ __
708.3	Age at death of the deceased neonate	_____ days after birth _____hours if on date of birth
709.1	Birth type of the deceased neonate	1. Singleton 2. Multiple (twins)
710	If twin, which twin was the deceased neonate?	1. First twin 2. Second twin
711	Sex of the deceased neonate	
712	How long it will take to reach health post from your residential home?	On foot _____minutes By car _____ munities (if any)
713	How long it will take to reach Health centre from your residential home?	On foot _____minutes By car _____ munities (if any)
714	How long it will take to reach hospital from your residential home?	On foot _____minutes By car _____ munities (if any)

Section-VIII: Use of Obstetric Services during the pregnancy of deceased neonate

Q#	Question	Response category
801	Did you see anyone for Antenatal care during the pregnancy of the deceased neonate?	1. Yes 2. No→ Q901
802	If Yes to Q801, how many ANC Visits did you made at all?	_____ Visits
803	If Yes to Q801, where was the place for ANC?	1. Hospital 2. Health centre 3. Health Post 4. Home of TBA/TTBA 5. Home of the respondent 6. other (Specify)_____
804	If Yes to Q801, whom do you see for the ANC?	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. Health Extension Worker 6. TBA/TTBA 7. Family Member 8. Other (specify) _____
805	If Yes to Q801, at what GA did you have the first ANC Visit?	_____weeks
806	If yes to Q801, did you receive any dose of TT?	1. Yes 2. No
807	If Yes to Q801, how may doses of TT did you receive?	_____ times
808	If Yes to Q801, did you receive any advice on self care during ANC Visits of this pregnancy?	1. Yes 2. No
809	If Yes to Q801, did you receive any advice on neonatal nutrition during ANC Visits of this pregnancy?	1. Yes 2. No
810	If Yes to Q801, did you receive any advice on breast feeding during ANC Visits of this pregnancy?	1. Yes 2. No
811	If Yes to Q801, did you receive any advice on infant immunization?	1. Yes 2. No

Section-IX: Neonatal care during labour and delivery for the deceased neonate

Q.#	Question	Response code
901	Where was t he place of delivery of the deceased neonate?	1. Hospital 2. Health centre 3. Health Post 4. Home of TBA/TTBA 5. Home of the respondent 6. other (Specify) _____
902	Why did you prefer this place?	_____
903	What was the mode of delivery	1. Normal Vaginal delivery 2. Operative delivery (C/S) 3. Vacuum or Forceps 4. Other (specify)_____
904	Who attended the delivery	1. Doctor 2. Nurse 3. Midwife 4. Health Officer 5. HEWs 6. TBA/TTBA 7. Family Member 8. Other (specify) _____
905	Why did you prefer this person?	_____
906	If the delivery was in health facility (hospital, health centre or health post) who accompanied you to give social support during delivery?	1. No one accompanied 2. Husband 3. Mother 4. Mother- in-Law 5. Other family member 6. Other (Specify) _____
907	If the delivery was not at health facility (at home, TTBA/TBA's Home) who accompanied you to give social support during delivery?	1. No one accompanied 2. Husband 3. Mother 4. Mother- in-Law 5. Other family member 6. Other (Specify) _____
908	How long was the duration of labour (from start to expulsion of placenta)?	1. <6 hours 2. 6-12 hours 3. >12 hours
909	How do you rate the size of the neonate at the time of birth? (READ THE OPTIONS)	1. Very Small 2. Smaller than usual 3. about average 4. Larger than usual
910	What is the approximate GA (duration of pregnancy) in weeks? (If told in month convert to weeks by using 1 month = 4 weeks)	_____weeks
911	Was the late part of the pregnancy, labour or delivery had any complications?	1. Yes 2. No
912	If Yes to Q911, What complication(s) was occurred? (multiple responses are possible)	1. Mother had convulsions 2. Newborn delivered feet first 3. Excessive bleeding 4. Emergency operative delivery (C/S) 5. Multiple birth (twins) 6. Other (Specify) _____
913	Did the water (amniotic fluid membrane) break before labour or during labour	1. Before labour 2. During labour
914	If break before labour, how much time before the onset of labour?	1. <1hour 2. 1-12 hours 3. >12 hours but <24 hours 4. 24 hours and above
915	How much time did the labour and delivery took?	1. less than 12 hours 2. 12 hours or more

Ask Q916-922 For all deliveries conducted out of health facility		
916	After the baby was born, what instrument was used to cut the cord?	1. New or boiled rather blood 2. Old unboiled rather blood 3. Household knife 4. Other (Specify) _____
917	What was used to tie the cord?	1. Not tied at all 2. Clean thread 2. Unclean/old thread 3. Other (specify)_____
918	What was applied to the stamp of umbilical cord after cutting?	0. Nothing was applied 1. Butter 2. Cow dung 3. Ash 4. Other (specify) _____
919	Was the baby Wrapped immediately after delivery?	1. Yes, before the placenta came out 2. Yes, but after placenta came out 3. Not wrapped at all
920	If rapped, what was used to wrap the baby?	1. New washed cloth 2. New unwashed clothe 3. Old washed cloth 4. Old unwashed cloth 5. Other (specify) _____
921	Where was the baby put after it was delivered?	1. Skin-to-skin contact with mother 2. Wrapped with clean close and put in contact with mother 3. Wrapped and put in separate place, not skin – to-skin contact with mother
922	How long after birth was the baby bathed for the first time?	1. <1 hour 2. 1-6 hours 3. after 6 hours but <12 hours 4. 12-24 hours 5. >24 hours
923	What was baby fed for the first time immediately after birth?	1. Breast milk/colostrums 2. Breast milk from other woman 3. Butter was given 4. Cow‘s milk 5. Commercial formula feed (Nido, mother‘s choice) 6. Glucose water 7. Plain water 8. Honey 9. Other (specify) _____
924	How long after birth was the baby initiated breast milk?	1. Within the first 1 hour 2. After 1 hour before 6 hours 2. 6-12 hours 3. >12 hours 4. Not breast feed at all
925	What is the situation of breast feeding in the first month after 2 hours of delivery till death?	1. Exclusive breast feeding 2. Supplementary feeding was given in addition to breast milk 3. Only formula feeding without breast milk 4. Other (specify) _____
926	If supplementary feeding was started what was given?	1. cow milk 2. gruel made of cereals 3. Other (specify) _____

Section-X: *Postnatal care for the deceased Newborn (2 hours – death)*

Q.#	Question	Response code
1001	Have you made any postnatal visit to health facility to check health status of the deceased baby?	1. Yes 2. No—Q1012
1002	If Yes to Q1001, where was the visit?	1. Hospital 2. Health Centre 3. Health post 4. Other (specify)_____
1003	If Yes to Q1001, whom did you see for the check up of your neonate during the visit?	1. Doctor 2. Nurse 3. Midwife 4. Other (specify)_____
1004	If Yes to Q1001, how many PNC visits have you had?	1.Oonly once 2. Twice 3. Three or more times
1005	If Yes to Q1001, how long after birth was the check up?	_____ days after birth (1st visit) _____ days after birth (2nd visit, if any) _____ days after birth (3rd visit, if any)
1006	If Yes to Q1001, did you receive any advice on self care during PNC visit?	1. Yes 2. No
1007	If Yes to Q1001, did you receive any advice on neonatal nutrition during PNC?	1. Yes 2. No
1008	If Yes to Q1001, did you receive any advice on breast feeding during PNC visit?	1. Yes 2. No
1009	If Yes to Q1001, did you receive any advice on infant immunization during PNC visit?	1. Yes 2. No
1010	Did the newborn receive any immunization on the date of birth?	1. Yes 2. No
1011	If yes to Q1010, which vaccine?	1.Polio-0 2. BCG 3. Other (specify) _____
1012	Was any vaccine given after first day of delivery for the neonate?	1. Yes 2. No
1013	If yes Q1012, what vaccine when?	Vaccine days after birth _____ _____ _____ _____ _____ _____ _____ _____
1014	How often does the neonate sleep under the bed net to prevent from Malaria?	1. Not at all 2. Sometimes 3. Always
1015	Was the neonate slept under the bed net the night before the survey?	1. Yes 2. No
1016	Does the bed net hang over the bed during the data collection time? (COMPLETE BY OBSERVING)	1. Yes 2. No

Section-XI: Causes of Neonatal death

Q.#	Question	Response code
1101	Is the mother alive at the time of interview?	1. Yes 2. No
1102	What is the relationship of the main respondent to deceased neonate?	1. Mother 4. Grandfather 2. Father 5. Aunt 3. Grandmother 6. Uncle 7. Other (Specify) _____
1103	Where was the neonate died?	1. Hospital 2. Health centre 3. Health post 4. On route to health facility 5. Home 6. Other (specify) _____
1104	If the death was at health facility, record the facility name and address.	Facility name_____ Date of admission _____

Open history question

1105. Could you please tell me about the illness that led to the death of the neonate?

Instruction to interviewer: allow the respondent to tell you about the illness that lead to the death of the neonate in her/his own words. Do not prompt except for asking „was there anything else?" until the respondent says there was nothing else.

_____
_____
_____
_____
_____
_____
_____

1106. Take a moment to circle all items mentioned spontaneously in the open history questionnaire. Use the following to guide you through the rest of the questionnaire.

1. Diarrhoea
2. Cough
3. Fever
4. Rash
5. Injury
6. Coma
7. Fit
8. Stiff neck
9. Tetanus
10. Measles
11. Kwashiorkor
12. Marasmus
13. Difficult breathing
14. Rapid breathing
15. Complicated delivery
16. Malformation
17. Multiple birth (twins)
18. Very small at birth
19. Very thin
20. Born early
21. Pneumonia
22. Accident
23. Malaria
24. Jaundice
25. Other terms (specify)

Q.#	**Question**	**Response code**
1107	What was the length of time the neonate was ill before he/she died?	_____days
1108	Was care (treatment) sought outside home while the neonate had this illness?	1. Yes 2. No
1109	If Yes to Q1108, from where was the care sought? (Multiple responses are possible, so prompt anywhere else)	1. Government hospital 2. Government health centre 3. Government health post 4. Private clinic 5. Private pharmacy, drug store or drug vender 6. Community based Health workers/Health extension workers 7. Traditional healer 8. Religious institutions 9. Other (specify) _____
1110	Did the neonate die from an injury, accident, poisoning, bite, burn or drowning?	1. Yes 2. No
1111	If Yes to Q1110, what kind of injury, accident or poisoning?	1. Motor vehicle accident 2. Fall 3. Drowning 4. Poisoning 5. Bite or sting by venomous animal 6. Burn 7. Violence 8. Other injury (Specify) _____
1112	Did the deceased neonate have any malformations at birth?	1. Yes 2. No
1113	If Yes too Q1112, Where was the malformation? (Multiple answers are possible)	1. Head 2. Body 3. Arms/hands 4. Legs/feet 5. Other (Specify) _____
1114	Was the neonate able to breath after birth?	1. Yes 2. No
1115	Was the neonate able to suckle or bottle feed in a normal way after birth?	1. Yes 2. No
1116	Did the neonate stop suckling in a normal way after starting?	1. Yes 2. No
1117	If Yes to Q1116, how long before death was the neonate stop suckling?	1. Less than 1 day 2. 1-2 days 3. More than 2 days
1118	If Yes to Q1116, how long after birth (at what age) did the neonate stop suckling?	1. Less than 1 day 2. 1-2 days 3. 3-7 days 4. 8-14 days 5. 15-28 days
1119	Was the neonate able to cry after birth?	1. Yes 2. No
1120	Did the neonate stop being able to cry?	1. Yes 2. No
1121	If Yes to Q1120, how long before death did the neonate stop suckling?	1. <1 day 2. 1 day or more

Q.#	Question	Response code
1122	During the illness that led to death, did the neonate have spasm or convulsions?	1. Yes 2. No
1123	During the illness that led to death, did the neonate have become unconscious?	1. Yes 2. No
1124	During the illness that led to death, did the neonate have bulging fontanel?	1. Yes 2. No
1125	During the illness that led to death, did the neonate have tetanus?	1. Yes 2. No
1126	During the illness that led to death, did the neonate have yellow discolouration of eyes?	1. Yes 2. No
1127	During the illness that led to death, did the neonate have redness or drainage from the umbilical cord stump?	1. Yes 2. No
1128	During the illness that led to death, did the neonate have areas of skin that were red and hot?	1. Yes 2. No
1129	During the illness that led to death, did the neonate have skin rash with bumps containing pus?	1. Yes 2. No
1130	During the illness that led to death, did the neonate have fever?	1. Yes , last for _____ days 2. No
1131	During the illness that led to death, did the neonate have frequent loose or liquid stools or diarrhoea?	1. Yes , last for _____ days 2. No
1132	During the illness that led to death, did the neonate cough?	1. Yes , last for _____ days 2. No
1133	During the illness that led to death, did the neonate have difficult breathing?	1. Yes , last for _____ days 2. No
1134	During the illness that led to death, did the neonate have fast breathing?	1. Yes , last for _____ days 2. No
1135	During the illness that led to death, did the neonate ever stop breathing for long time and started again?	1. Yes 2. No
1136	During the illness that led to death, did the neonate have chest indrawing?	1. Yes 2. No
1137	During the illness that led to death, did the neonate have flaring nostrils?	1. Yes 2. No
1138	During the illness that led to death, did the neonate have pneumonia?	1. Yes 2. No
1139	Has the mother of the neonate ever been tested for HIV?	1. Yes 2. No
1140	If Yes to Q091, was the HIV test ever positive?	1. Yes 2. No
1141	Has the mother of the neonate ever been told that she had —AIDS" by health worker?	1. Yes 2. No

I have completed my Interview. Thank you for your cooperation.

Annex 2.7. Phase-two interview guide

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Informed consent for In-depth Interview of Key informants for the study entitled *"Neonatal care practices, Neonatal morbidity and treatment seeking behaviour by mothers in Jimma Zone, Southwest Ethiopia."*

Key informants: Health care providers, TBAs and HEWs

Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet

Introduction:
Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are conducting in-depth interview with individuals who are selected purposively based on their experience and rich source of information concerning Neonatal care practices, neonatal morbidity and treatment seeking practice in this community.

Purpose of the research
The purpose of the study is to assess the status of neonatal care, neonatal morbidity, and treatment seeking behaviour of mothers. The findings of the study will be used to plan interventions to improve neonatal care practices in the future.

Procedures
You are among the 12 key informants selected purposively for this in-depth interview. I will ask you few questions concerning the neonatal care practices, neonatal illness and treatment seeking practices in this community. The interview will take about 1:00 hour. So, I request your volunteer participation.

Risks and discomfort
The interview may take some of your time. However, we try to make it short and to the point and guide you through the interview.

Benefits
There will be no direct benefit to you, but based on the information you provide us, we will design strategies to improve the interventions targeted to improve neonatal care practices so as to reduce neonatal mortality.

Confidentiality
The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw
You can refuse to answer any question to which you are not comfortable. You may stop participating in the interview at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving neonatal health services in the future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participant

Signature/finger print _____ date _____
(Proceed with the interview)

No ☐ **(Terminate the interview)**

Signature of the interviewer

Name _____ Signature _____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note:

In case of any unclearity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

Respondents back ground

1. Category of participant: 1. IMNCI provider 2. TBA 3. HEW
2. Sex _____, age _____, Educational status _____,

Interview Guide questions

1. How do you see the breast feeding practices of mothers in this community?
    1.1. Do all mothers breast feed their neonates?
    1.2. When do they start?
    1.3. What do they make the colostrums?
    1.4. Is there something given to the newborn as pre-lacteal feeding before breast milk?
    1.5. Is there any practice of supplementary feeding in the first month of life? If so what do they give?
2. How do you see the thermal care for the neonates particularly during home deliveries?
    2.1. Do you think all the newborns are raped immediately? When and with what they used to wrap? Tell me please what they actually do?
    2.2. When do the newborns washed? With what?
3. How do you see the cord care practice during home delivery in this community?
    3.1. Do they cut cord?
    3.2. With what they cut the cord?
    3.3. Do they apply anything? If so would you explain?
4. How do you see the newborn immunization in this community?
5. What are the common illnesses of neonates in this community?
6. How do you see the treatment seeking behaviour of mothers/caregivers for neonatal illnesses?
    6.1. What treatment options do they use for neonatal illnesses?(traditional, modern, religious? etc)
    6.2. Do they take early to health facility?
    6.3. What are the barriers to treatment seeking from health facilities? (Knowledge? Distance, transportation cost, etc?)
7. What do you think are the common cause of neonatal death in this community?
8. Any additional point you have related to neonatal care practices to be improved in the future?

I have completed my interview thank you very much!

Annex 2.8. Phase-two FGD guide

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Informed consent for FGD Participants for the study entitled *"Neonatal care practices, Neonatal morbidity and treatment seeking behaviour by mothers in Jimma Zone, Southwest Ethiopia."*

Participants: 8-10 Mothers having infants of <6 months of age.

Investigators: Mr. Gurmesa Tura, Prof. Mesganaw Fantahun and Dr. Alemayehu Worku

Part I – Information sheet

Introduction:
Good morning/afternoon! My name is _____. I represent the research team from Addis Ababa University. We are conducting focus group discussions with mothers having neonates who are selected purposively based on their experience and rich source of information concerning neonatal care practices, neonatal morbidity and treatment seeking behaviour in this community.

Purpose of the research
The purpose of the study is to assess the status of neonatal care practices, neonatal morbidity and treatment seeking behaviour in Jimma Zone. The findings of the study will be used to plan interventions to improve the neonatal care practices and services in the future.

Procedures
You are selected purposively for this Focus group discussion like the other group of mothers. I will raise few questions concerning neonatal care practices, neonatal morbidity and treatment seeking practice so that you can generate ideas for interventions by discussing on them. The discussion will take about 1:00 hour. So, I request your volunteer participation.

Risks and discomfort
The discussion may take some of your time. However, we try to make it short and to the point and guide you through the interview.

Benefits
There will be no direct benefit to you, but based on the information you provide us, we will design strategies to improve the interventions targeted to improving neonatal health.

Confidentiality
The information that we collect in this study will be kept confidential. Your name will not be written in this form and the information we collect from you will not be shown to anyone outside of this research. The collected data will also be used in aggregated form. The hard copies will also be kept in a locked cabinet and will not be divulged to anyone, except the investigators.

Right to refuse or withdraw
You can refuse to answer any question to which you are not comfortable. You may also stop participating in the discussion at any time if not convenient for you without losing any of your rights as a participant. However, your active participation and genuine responses have paramount importance in improving maternal health services in future.

Part II – Certificate of consent

With due understanding of the aforementioned information, are you willing to participate in the study?

Yes ☐

I have been requested to take part in the research and the foregoing information has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the interview at any time without in anyway affecting my right.

Signature/finger print of the participants

1. Signature/finger print _____ date _____
2. Signature/finger print _____ date _____
3. Signature/finger print _____ date _____
4. Signature/finger print _____ date _____
5. Signature/finger print _____ date _____
6. Signature/finger print _____ date _____.
7. Signature/finger print _____ date _____
8. Signature/finger print _____ date _____.
9. Signature/finger print _____ date _____
10. Signature/finger print _____ date _____

(Proceed with the interview)

No ☐ **(Terminate the interview)**

Signature of the Moderator : Name _____ Signature_____ date _____

Signature of the Note taker: Name _____ Signature_____ date _____

Supervisors/Researcher remark and signature

Name _____ Signature _____ date _____

Note: In case of any unclearity you can communicate the principal investigator through the telephone Number: +251-0912-06-16-46.

I-Participants back ground

(Don‘t write their name, code as P1, p2, p3….p12 under the column headed discussant code)

S/N	Discussant code	Age	Educational background	Gravidity	Parity	Place of last delivery

II-Discussion guide questions

1. How do you see the newborn breast feeding practices of mothers in this community?

   Probe:

   - Do all mothers breast feed their neonates
   - When do they start
   - What do they make the colostrums
   - Pre-lacteal feeding
   - Supplementary feeding

2. How do you see the thermal care for the neonates particularly during home deliveries?

   Probe:

   - Do they wrap immediately?
   - With what they used to wrap?
   - What is the purpose of wrapping?
   - Do the neonates washed? when? With what? Why? Or why not?

3. How do you see the cord care practice during home delivery in this community?

   Probe:

   - Do they cut cord?
   - With what they cut the cord?
   - Do they apply anything? If so, would you explain what and why?

4. How do you see the newborn immunization in this community? What beliefs are there?
5. What are the common illnesses of neonates in this community?
6. How do you see the treatment seeking behaviour of mothers/caregivers for neonatal illnesses?
   - 6.1. What treatment options do they use for neonatal illnesses?(traditional, modern, religious? etc)
   - 6.2. Do they take early to health facility?
   - 6.3. What are the barriers to treatment seeking from health facilities? (knowledge? Distance, transportation cost, etc?
7. What do you think are the common cause of neonatal death in this community?
8. Any additional point you have related to neonatal care practices to be improved in the future?

I have completed my discussion points thank you for your participation!

13. DECLARATION

I, the under signed investigator, declare that this is my original work, which has never been submitted to this or any other university and that all the recourses and materials used for the dissertation have been duly acknowledged.

Name: Gurmesa Tura Debelew

Signature: _____

Date: _____

Place: School of Public Health, Addis Ababa University

This dissertation has been submitted for examination with my approval as a university supervisor.

Name: Prof. Mesganaw Fantahun

Signature: _____

Date: _____