MAGNITUDE AND DETERMINANTS OF UNDER-FIVE MORTALITY AND ITS ASSOCIATION WITH MATERNAL MENTAL DISTRESS IN GAMO GOFA ZONE, ETHIOPIA

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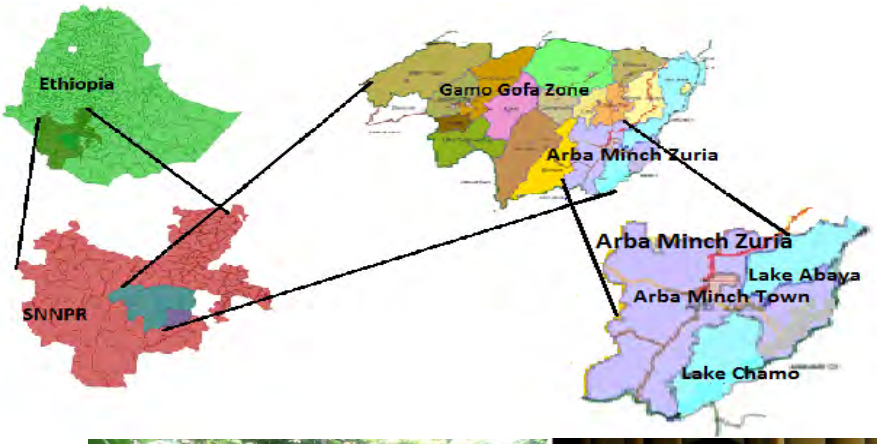

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Original Papers

This thesis is based on the following original research papers:

Paper I: Girma Temam Shifa, Ahmed Ali Ahmed, Alemayehu Worku Yalew. Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia: A community based cross-sectional study. BMC Pediatrics, 2016, 16:30. DOI 10.1186/s12887-016-0568-z

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Paper III: Girma Temam Shifa, Ahmed Ali Ahmed, Alemayehu Worku Yalew. Maternal and child characteristics, practices and health interventions that affect childhood mortality: the case of Gamo Gofa Zone, Southern Ethiopia. Under review at Journal of BMC Pediatrics, 2016. BPED-D-16-00384

Paper IV: Girma Temam Shifa, Ahmed Ali Ahmed, Alemayehu Worku Yalew. The relationship between under-five child death and maternal mental distress in Gamo Gofa Zone, Southern Ethiopia: A community based comparative cross-sectional study. Under review at Journal of Women's Health (BMC), 2016. BMWH-D-16-00062

List of Acronyms

AIDS: Acquired Immunodeficiency Syndrome
ANC: Antenatal Care
AOR: Adjusted Odds Ratio
ARIs: Acute Respiratory Infections
CI: Confidence Interval
CL: Confidence Level
CMD: Common Mental Disorder
COR: Crude Odds Ratio
DHS: Demographic and Health Survey
DSS: Demographic Surveillance System
EDHS: Ethiopian Demographic and Health Survey
FGD: Focus Group Discussion
GBD: Global Burden of Disease
HEW: Health Extension Worker
HICs: High-Income Countries
HIV: Human Immunodeficiency Virus
IDIs: In-Depth Interviews
IMR: Infant Mortality Rate
IRB: Institutional Review board
KMs: Kilo Meters
LMICs: Low and Middle Income Countries
MDGs: Millennium Development Goals
NGO: Non-governmental organization
OR: Odds Ratio
ORT: Oral Rehydration Therapy
PCA: Principal Component Analysis
PNC: Post Natal Care
SD: Standard Deviation
SDGs: Sustainable Development Goals
SNNPR: Southern Nation's Nationalities and People Region
SRQ: Self Reporting Questionnaire
WHO: World Health Organization

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Summary of the thesis

Background: Although there is documented reduction in under-five mortality in the country (Ethiopia), the mortality rates are still high that about one in every 21 Ethiopian children die before their first birthday and one in every 15 children die before their fifth birthday. Besides, it is clear that efforts should be continued to sustain the reduction of mortalities to achieve the newly endorsed sustainable development goals (SDGs) target. The death of a child is one of the most stressful events that a mother may experience during the course of her lifetime and may lead to sustained mental health effect. Studies investigating post child loss maternal mental health status in developing countries, particularly in Ethiopia are rare. There are inconsistencies with regard to determinants of under-five mortality found by few previous studies. As Demographic Surveillance System (DSS) sites are becoming sources of evidence for magnitude and cause of mortalities in areas where vital event registrations are lacking (especially in Africa, Asia and Oceania), mortality rates in such sites in comparison with non-DSS areas need to be investigated. As the Arba Minch DSS is new, mortality studies in general and determinants of under-five mortality and its relation with maternal mental distress in particular are limited. All these call for investigating determinant factors of childhood mortality and its effect on maternal mental wellbeing to strengthen existing ones and design new interventions gearing to the specific context/community for sustained reduction of mortality and improvement of maternal mental well-being for attainments of maternal and child health related targets of SDGs.

Objective: To assess the magnitude and determinants of under-five mortality and its association with maternal mental distress in Gamo Gofa Zone, Southern Nations, Nationalities and People's Region, Ethiopia.

Methodology: Mixes of methods were utilized to address each of the specific objectives. Accordingly, prevalence (simple cross-sectional) study- to assess the prevalence of childhood mortality, matched case control (deceased under-five children as cases and two live under-five children as matched controls) - to determine determinants of under-five mortality and comparative cross-sectional (mothers with child death as exposed and two mothers with live child as matched unexposed) - to determine the effect of child death on maternal mental health were implemented. The study took place in 2014. The study populations were under-five

children and their respective mothers. For the prevalence study, a census of selected kebeles (the smallest administrative units) was conducted and additional data from the Arba Minch DSS database were identified. Accordingly, a total of 20,161 under-five children were identified and included for the prevalence analysis. A total of 381 cases and 762 controls for the case control study were included. For the comparative cross sectional study, 356 exposed and 712 unexposed were included. Maternal mental distress was assessed with the World Health Organization's (WHO's) self-reporting questionnaire (SRQ-20). Data were entered using Epi Info Version 3.5.1 and analysis was performed by open-epi version 2.3 and STATA 11 as appropriate. In all cases, weighted analysis was conducted to account for unequal selection probability. Chi-square with the corresponding p-value was determined to assess bivariate association between the dependent and the independent variables for the first objective. Extended Mantel-Haenszel chi-square for linear trend was performed to assess presence of linear trend in under-five mortality and maternal mental distress. Bivariate and multivariable conditional logistic regression was applied to assess predictors of under-five mortality and maternal mental distress.

Result: The overall weighted under five, infant and neonatal mortalities with their corresponding 95% confidence intervals were: 42.76(39.56-45.97), 33.89(31.03-36.76) and 18.68(16.53-20.83) per 1000 live births, respectively. Majority (82%) of neonatal deaths occurred within the first seven days of life. Under-five mortality was found to be significantly higher among non-DSS rural kebeles (52/1000 live births) and overall rural kebeles (43.1/1000 live births).

Maternal education of grade nine and above (adjusted odds ratio (AOR) of 0.34(0.16-0.72)), maternal marital status of separated/divorced or widowed (AOR of 3.60(1.23-10.47)) and paternal occupation of daily laborer (AOR of 2.34(1.29-4.23)) were distal factors significantly associated with under-five mortality. Lack of a separate kitchen for cooking was environmental contamination related factor that was significantly associated with under-five mortality (AOR of 1.77(1.16-2.70)). Among maternal and child related factors: previous birth interval (AOR of 0.48(0.28-0.82) for 24-36months and AOR of 0.46(0.26-0.79) for more than 36 months), history of child death before the index child (AOR of 1.97(1.07-3.61)), being multiple birth (AOR of 13.72(5.26-35.79)) and live birth after the index child (AOR of 5.06(2.80-9.16)) were significantly associated with under-five mortality. Among personal illness control related factors: lack of post natal care (AOR of 2.27(1.25-4.11)), immunization status of the child (AOR of

3.62(2.02-6.50) for partially immunized and AOR of 11.02(5.16-23.53) for not immunized) and lack of vitamin A at least once after six months of age (AOR of 7.61(4.72-12.26)) were significantly associated with under five mortality. Lack of breastfeeding (AOR of 8.09(4.08-16.05)) and delaying of first bath after birth (AOR of 0.50(0.34-0.73)) were also significantly associated with under-five mortality. Unexpectedly, factors such as place and assistant of delivery were not significantly associated with under-five mortality. Mothers who lost their children had significantly high rate of mental distress than their counterparts (AOR of 1.84(1.11-3.04). Similarly, mothers with child loss reported a significantly high rate of suicidal ideation (23.3%), p-value of 0.003.

Conclusions and Recommendations: Mortality rates identified in the current study are lower than other previous reports in the country. Significant number of children died during their early days of life. Socioeconomic factors like maternal education, husband occupation and marital status of mothers are shown to significantly affect childhood mortality. Factors such as having separate kitchen, post natal care, long birth interval, delaying first bath after birth, immunization and supplementation of vitamin A for children older than six months were among proximate factors which were significantly associated with low under-five mortality. Significantly high proportions of women with child loss were suffering from mental distress compared to those without child loss, including higher rate of suicidal attempts.

Strengthening of maternal and child health interventions during pregnancy, delivery and postnatal period is recommended in order to mitigate majorities of neonatal mortalities that occur during early day of life. Investing on maternal education by targeting those at risk is crucial and may help to avert majority of childhood mortality. In order to maintain reduction of childhood mortality beyond post millennium development goals and attain the newly endorsed SDGs' targets, promotion of having a separate kitchen and strengthening of maternal and child health interventions, such as post natal care, family planning, immunization and supplementation of vitamin A for children older than six months is highly recommended. Screening of maternal mental health problems by incorporating simple common mental distress assessing tools such as SRQ into the maternal and child health care programs of health facilities, that is guided by stronger local evidences may have significant effect in reducing the impact of maternal mental health problems in the community.

1. Introduction

1.1. Background of the study

The progress made towards achieving the health-related Millennium Development Goals (MDGs) varies, both between countries and across the range of different goals. The target related with under-five mortality (reduction by two thirds) is the one with substantial progress, in terms of the proportion of the target achieved. Under-five mortality rates declined by more than half from 1990 to 2015, falling from an estimated 91 deaths per 1000 live births to 43 deaths per 1000 live births, respectively (1, 2). Much of that reduction has been achieved in recent years, with the rate of decline increased from 1.8 percent in 1990-2000 to 3.9 percent in 2000-2015 (2).

Despite such achievements, child survival remains an urgent concern globally (2, 3). Unacceptably, about 16,000 children still die every single day globally. The level of under-five mortality remains high in certain regions of the world, especially in Southern Asia and sub-Saharan Africa. Sub-Saharan African Region continues to be the Region with the highest rate of under-five mortality. For instance, in 2015 the under five-mortality rate in sub-Saharan African Region was the highest in the world, 83 deaths per 1,000 live births, nearly 14 times the average in developed countries (2).

Unless accelerated efforts to tackle childhood morbidity and mortality (by addressing equity) are undertaken in the coming years, it is anticipated that almost 70 million children will die before reaching their fifth birthdays by the year 2030 (the deadline for the Sustainable Development Goals (SDGs)) (3). It is also urgently recommended to accelerate the pace of progress to achieve the SDGs target of under-five mortality rate of 25 or fewer deaths per 1,000 live births by 2030, particularly in high mortality countries in sub-Saharan Africa. It is anticipated that a total of 47 countries need to increase their pace of progress to achieve the SDG target of under-five mortality rate. Among those, 34 are in sub-Saharan Africa (2).

In recent years, child mortality in Ethiopia is reported to show a decrement. For instance, infant mortality declined by 39 percent over the 15-year period between the 2000 Ethiopian Demographic and Health Survey (EDHS) and the 2011 EDHS, from 97 deaths per 1,000 live births to 59 deaths per 1,000 live births. Under-five mortality also decreased by 47% during the

same period (declined from 166 deaths per 1,000 live births to 88 deaths per 1,000 live births) (4). The decline reported to be continued in the recent EDHS with infant and under-five mortality of 48 and 67 deaths per 1,000 live births, respectively. Although such decline has been reported, child mortality rate in Ethiopia remains to be among the highest in the world. As a result, about one in every 21 Ethiopian children dies before his/her first birthday, and one in every 15 children dies before the fifth birthday (5). Mortalities in Southern Nations, Nationalities and People's Region (SNNPR) were among the highest in the country. Under five, child, infant, post neonatal and neonatal mortalities in the Region were 116, 41, 78, 41 and 38 per 1000 live births, respectively (4).

Mental health is an inseparable part of public health and significantly affects countries and their human, social and economic capital (6). Good mental health allows for cognitive and emotional flexibility, which are the basis for social skills and resilience in the face of stress. This mental capital is vitally important for the healthy functioning of families, communities and society (6). Common mental disorders such as anxiety and depression are the third leading causes of disease burden globally for women between 14 and 44 years of age (7). By 2030, these are expected to rise to first place, ranking above heart disease and road traffic injuries (8).

Maternal mental disorders are approximately three times more prevalent in low- and middle-income countries (LMICs) than in high-income countries (HICs), where the related burden of disease estimates range between 5.2% and 32.9% (9, 10). In HICs, maternal suicide is the leading cause of death during the perinatal period, and while there is a relative dearth of information about maternal suicide in LMICs, they are assumed to be high (11).

A series of studies have demonstrated that the impact of mental health problems in pregnant women, and up to one year after childbirth, in LMICs differed from what was known from HICs (11), in two important aspects: 1) The prevalence of maternal mental disorders is significantly higher in LMICs and 2) the impact on infants goes beyond delayed psycho-social development and also includes low birth weight, reduced breast-feeding, hampered growth, severe malnutrition, increased episodes of diarrhea and lower compliance with immunization schedules.

In addition to the economic losses that mental disorders will bring, maternal mental disorder will have impact on the wellbeing of children and the family as a whole. Studies have shown that

early childhood failure to thrive, as indicated by under nutrition and stunting in infants, is independently associated with depression in mothers (12, 13). Maternal mental health problem was shown to have devastating effect on the subsequent pregnancy outcome in terms of fatal congenital malformation, stillbirth and neonatal death (14). Untreated maternal mental illness affects infant and child growth (13) and the quality of child care (12), resulting in compromised child development (10, 15).

Depression in mothers may also lead to increased maternal mortality, both through adversely affecting physical health needs as well as more directly through suicide. However, the earlier these conditions are recognized and addressed, the greater the chances of minimizing their impact (11, 16). It has also been shown that brief counseling can significantly reduce morbidity in parents after child death (17).

1.2. Statement of the problem

Investing on child health interventions not only saves lives and averts sufferings, but also improves the potential of children, their communities and countries. In other words, when the health systems of a country fail to prevent childhood illnesses, the country pays a price in the form of treatment costs and lost future productivity (3).

Progress in child survival worldwide has been described as one of the greatest success stories of international development, with child deaths being almost halved over the last two decades compared to the 1990 MDGs baseline. Despite such achievements, unacceptably still high number of children die before celebrating their fifth birth date, especially in Southern Asia and sub-Saharan Africa (1, 2). The Sub-Saharan African Region is the region with the highest rate of under-five mortality in the world. For instance, in 2015 the under five-mortality rate in sub-Saharan African Region was 83 deaths per 1,000 live births, nearly 14 times the average in developed countries(1, 2). As a result, accelerated and sustainable effort for tackling this unacceptable high mortality is recommended by international organizations by maintaining the momentum established during the MDG era (1, 2).

Following the end of the MDGs era, the international community laid a framework to reduce under-five mortality globally by setting a target to reduce the number of children who will die before their fifth birthdate to be less than 25 per 1000 live births. Unless accelerated efforts are taken, it is anticipated that more children will continue to die and the SDGs will not be achieved by 2030. By now 79 countries have under-five mortality rates above the SDG target of 25 under-five deaths per 1000 live births (1). Continued investigation of childhood mortality and its determining factors will help policy makers, managers and implementers of child health intervention to design and re-design effective strategies for accelerated efforts to achieve the targets.

Ethiopia is one of the countries with better progress in achieving the MDG target of reducing under-five mortality by two thirds in the past two decades. However, the problem in the country is among the highest in the world. The country is among the 79 countries with under-five mortality rates above the SDG target of 25 under-five deaths per 1000 live births. Ethiopia is among the top 37 countries with highest under-five mortality in the world, with an estimated

under-five mortality of 59 deaths per 1000 live births in 2015 (3), which is slightly less than the latest EDHS report of 67 per 1000 live births (5).

The country has envisioned to reduce under five mortality rate to 29/1,000 live births in 2019/2020 through its latest "National Newborn and Child Survival Strategy (2015/16-2019/20)". Through "Promise Renewed Child survival Roadmap", the country also aims to end preventable child death with the goal of dropping under-five mortality rate to less than 20/1,000 live births by 2035 (18). All these call for continued and high impact evidence based interventions in the years to come.

Wide regional and place of residence variations in under-five mortality in the country have been documented. Under-five mortality rates range from 53 in Addis Ababa to 169 per 1,000 live births in Benishangul-Gumuz. The rate of under-five mortality for rural children was 1.4 times higher than that for urban children (114 vs 83 deaths/1000 live births) (4). Such disparities in child survival are also a global issue and addressing them is an urgent global (3) and national (18) recommendation, by prioritizing those at greatest need for fulfillment of the SDGs targets (3). This requires much greater disaggregation of evidence by factors for such variations such as geographic locations (1).

SNNPR is one of the regions with high under-five mortality in the country with 116 per 1,000 live births (4). It's being a home to a wide variety of culturally different ethnic groups, the mortality rate and child care practices in SNNPR are expected to vary from place to place. Such variation calls for more local studies for better understanding of the problem and to design context specific interventions.

Different factors have been implicated for the continued high rate of under-five mortality. Henry Mosley and Lincoln Chen (19) developed and proposed an analytic framework for the study of determinants of child mortality, that would integrate the two research methodologies (social science research, which focuses largely on the roles of socioeconomic and cultural factors in child deaths, and medical research, which focuses on specific disease processes and use morbidity as the most common outcome variable). The conceptual framework has an idea that all background (socio-economic and cultural) variables have to operate through a limited set of proximate determinants that directly influence the risk of disease and the outcome of disease

processes (19). The idea of proximate determinants (or intermediate variables) analytic framework was first introduced by Davis & Blake (20) and later applied by Bongart (21) for the study of fertility. They argued that any social factor influencing the level of fertility had to operate through proximate/ intermediate variables (20, 21).

Most studies investigating determinant factors of child mortality in developing countries, including Ethiopia are context insensitive (22-27), they either are not comprehensive in controlling context level factors or do focus on individual factors rather than contextual/community level factors or consider these factors as individual variables. Among others, the following two measures could help address this problem, 1) at design stage matching the study participants by context level variable, which has additional advantage of controlling known and unknown confounding variables; 2) controlling context level variables during analysis by using appropriate statistical methods that allow controlling of clustering effect, such as multi-level analysis. In this study, the two groups (cases vs controls) were matched by place of residence and applied conditional logistic regression in the analysis after assessing presence of clustering effect. Some of the studies done in the past were also cross-sectional in design (25-28).

Many studies have shown that persons exposed to stressful life events experience mental health problems at a rate higher than that observed in the general population (29-32). For example, abortion was shown to be associated with an increase in the risk of mental disorders; women who had had abortions had rates of mental disorder that were about 30% higher. But, there were no consistent associations between other pregnancy outcomes and mental health (33).

Large scale longitudinal studies of widowhood showed that major bereavement can seriously affect mental health (34-37). Taken together, these studies suggest that up to one-third of the bereaved may manifest serious psychological disturbance within two months of the death. One to two years later, up to one-fifth can be expected to report such disturbances. Notably, this mainly seems to reflect ongoing distress, in that depression soon after the loss appears to predict later depression (35). It has also been shown that death of a loved one can be an extreme stressor, particularly when the death is sudden, when there is evidence of intentional harm and body mutilation, and when the deaths occur among children (38, 39).

The death of a child is, undoubtedly, a highly traumatic life event for parents. Such traumatic pressure is expected to be more notable for mothers (40, 41) as it is the mother who carry the child in her womb and directly feel the pain of labor. The death of a very young child, as in the case of stillbirth and neonatal death, has been shown to have the potential to invoke severe emotional distress in parents (42, 43).

It has also been shown that, miscarriages, induced termination of pregnancy and stillbirths all provoke a grief reaction, however, the degree of grief has been directly related to the length of gestation and to whether it was a wanted child or not (44). Mothers with no later pregnancy and third and above in the birth order of the still birth were found to have high risk of depression (45). It has also been demonstrated by other studies that, there is an impact of the death of a baby on women's mental health (41, 46) and as a result, bereaved mothers were found to be at increased risk for psychological distress at 2, 8, 15 and 30 months after their loss than mothers with live children (46).

It is also shown that the risk of psychiatric hospitalization is high among parents with child death, especially mothers (40). The effects of the death of a child are shown to be longstanding (47). There is strong evidence, however, that all such life events do not invariably cause psychological disturbance. Even following highly traumatic events, such as the death of a spouse, only minorities of individuals appear to develop serious or ongoing psychological disorder (34, 35, 48, 49). The effects are expected to be context dependent. The association between child loss and maternal mental distress in Ethiopia has not been investigated and documented yet.

In summary, studies investigating determinant factors of child mortality in developing countries, including Ethiopia are context insensitive, they mainly focus on individual factors rather than contextual/community level factors or consider them as individual variables, and are cross-sectional in design. And most of them are based only on few kebeles (smallest administrative Units) of Demographic Surveillance System (DSS) sites. Owing to changes in life style of the population and variation in child survival across nations and sub-national regions, factors affecting childhood mortality may vary by place and time. Therefore, continuous monitoring of determinant factors of childhood mortality is crucial.

Some studies have shown that stressful events like child death have effect on mental health of the victim, however, not all such events are found to have similar effects. Besides, as the prevalence and impact of maternal mental health on the wellbeing of children is different between developed and developing countries, it may have a different relation with child death in the two settings. In addition, the relationship between child death and maternal mental health has not been well investigated in developing countries in general and in Ethiopia in particular. This study is hence, envisaged to throw additional insight in to the problems.

1.3. Rationale of the study

Reduction of child mortality has continued to be a global public health priority and one of SDGs targets (3). Disparities in childhood mortality continue to exist globally (3) and nationally (4). Reducing such disparities is one of the strategies recommended for achieving under-five mortality related SDGs target (3, 18). This calls for more local studies for better understanding of the problem and design context specific interventions.

Because of the change in life style of the population and variation in child survival across nations and sub-national regions (2, 4), there is an apparent need for periodic and context specific childhood mortality studies to monitor the changing trends in magnitude, cause and precipitating factors for designing new strategies and re-designing existing ones.

Although there is documented reduction in child mortality and indication of the achievement of child health related MDG target by the country (Ethiopia) (50), accelerated efforts should be continued to sustain the reduction in order to reach the SDGs' target of 25 deaths per 1000 live births by 2030 (3). Continued investigation of the extent and determinants of childhood mortality to identify areas to be focused on and prioritized for subsequent and targeted interventions are crucial for such accelerated efforts.

Except for the two studies which tried to compare childhood mortalities between DSS and EDHS data (51, 52), most of under-five mortality studies conducted in the country were based only on few kebeles (smallest administrative Units) of Demographic Surveillance System (DSS) sites (53-56). This study assessed the magnitude and determinant of childhood mortality by including large number of both DSS and non-DSS kebeles and compared mortalities between DSS and non-DSS kebeles, which will be an important input for national and international evidence to understand the situation in the two sets of communities (DSS vs non-DSS), as DSS sites are becoming source of mortality evidences in resource limited settings.

There is evidence that common mental health problems, including depression and anxiety, are two to three times more prevalent among pregnant women and mothers of infants in resource constrained settings than in high-income countries (57). Their negative impacts on children are also shown to be severe and different in developing countries (11). As a result, the effect of child

death on maternal mental health is expected to be context dependent. In Ethiopia, studies investigating the extent and associated factors of the problem among bereaved mothers are lacking.

Showing the extent of the problem may help to attract policy directions in order to intervene, as the recovery process with appropriate psychiatric intervention is shown to be accelerated and that helps to settle an uncomplicated grief reaction (58). Besides, it may help to highlight the indirect impact of reduction/prevention of child mortality on the maternal mental wellbeing which is expected to have a positive impact on the development of the nation as depression is associated with substantially reduced quality of life and functional capacity of the women (57). Previous studies established the negative effect of maternal mental distress on child wellbeing and survival. Showing the other direction (effect of child death on maternal mental distress) may shed light on the vicious nature of the problems and the synergistic benefit of an intervention targeting maternal mental distress and childhood mortality.

As Arba Minch DSS, which is established as a field research laboratory for the Arba Minch University, is a relatively young DSS site in the country, there have been very few researches undertaken so far. Researches related to determinants of under-five mortality and maternal mental health in general and the relationship between child death and maternal mental distress in particular were lacking in the area.

Therefore, this study ventured to investigate the magnitude of childhood mortality and its predicting factors in southern Ethiopia by including the kebeles of Arba Minch DSS sites. The study also investigated the association between child death and maternal mental distress. The study aimed to identify areas to be focused on in terms of programmatic and policy directions in order to sustain the reduction of childhood mortality and improve maternal and child health status beyond MDGs and attain maternal and child health related SDGs targets. It also aimed to fill the gaps that existed in the country in general and in the study area in particular in terms of discrepancies or absence of evidence for determinants of childhood mortality and association between child loss and maternal mental distress by providing representative but also more localized evidences.

1.4. Literature review

The literature review was made with the objective of identifying researches/literatures on child mortality in general and determinant factors of child mortality in particular in order to understand the problem and identify any research gaps in the area. It also aimed to identify researches/literatures assessing the relationship between stressful life events particularly child death and mental health of the mother. To capture all relevant literature, all possible electronic and paper based sources were searched. For example, electronic sources such as: Medline/PubMed, Google scholar, the Cochrane database for clinical trial and systematic review and database of local journals were searched. Hand search of local paper based journals/sources were made to access other published and unpublished relevant literatures. The search was also supplemented by examining the bibliographies of the reviewed articles. The literatures were organized using EndNote version 6 software.

1.4.1. Magnitude of under-five mortality

Child mortality continues to decline in many countries; the number of children dying before reaching the age of five decreased from over 12.7 million in 1990 to 5.9 million in 2015 worldwide (2). The global under-five mortality rate declined by 53 percent from 91 to 43 per 1,000 live births in this period (2). The rate of reduction in under-five mortality accelerated in the last decades globally, annual rate of reduction increased from 1.8 percent in 1990–2000 to 3.9 percent in 2000–2015 (2).

Despite such progress and decline in child mortality worldwide, many countries did not achieve the child mortality related target of MDGs. Some 50 of the 75 Countdown countries (countries with high child mortality (under-five mortality rate of >=90 per 1,000 live births or >=50,000 child deaths a year in 2004)) were projected to fail to achieve the child mortality reductions required by MDG 4 (59). Unless actions are designed differently by addressing inequity, it is anticipated that almost 70 million children will die before reaching their fifth birthdays by the year 2030 (3). The gap between developed and developing countries will also continue in the SDGs era (3).

Inequities in child mortality between high income and low income countries continue to be high. In 2015 the under five-mortality rate in low income countries was 76 deaths per 1,000 live births, more than 10 times the average rate in high income countries (7 deaths per 1,000 live births) (60).The highest being in the WHO African Region (81 per 1000 live births), more than 7 times higher than that in the WHO European Region (11 per 1000 live births). Many countries in this Region still have very high under-five mortality. This Region is home to six of the seven countries with an under-five mortality rate above 100 deaths per 1,000 live births (60).

In Ethiopia, infant mortality was reported to have declined by 39 percent over the 15-year period between the 2000 EDHS and the 2011 EDHS, from 97 deaths per 1,000 live births to 59 deaths per 1,000 live births (4). Under-five mortality also decreased by 47% during the same period (declined from 166 deaths per 1,000 live births to 88 deaths per 1,000 live births) (4). These figures reported to be declined to 48 and 67 deaths per 1,000 live births during EDHS 2016, for infant and under five children respectively (5). Although such decline has been reported, child mortality rate in Ethiopia has been among the highest in the world. Ethiopia was among five countries where almost half of global childhood mortality occurred in 2015 (3). It is also among the 79 countries with under-five mortality rate above 25 (SDGs target) (60).

According to the EDHS 2011 Report, the neonatal mortality rate was 37 deaths per 1,000 live births, the post-neonatal mortality rate was 22 deaths per 1,000 live births, and the perinatal mortality rate was 46 per 1,000 pregnancies (4). The 2016 EDHS indicated that neonatal and post-neonatal mortality rates also have declined to 29 and 19 deaths per 1,000 live births, respectively (5). Because of recall and selective omission biases, the EDHS report acknowledged that the findings may suffer from distortion of the age pattern of mortality and the possibility of underestimation of mortalities (4).

There are wide regional and residence setting variation in under-five mortality in the country. Childhood mortality in the country is higher in rural areas (114 death per 1000 live births) than in urban areas (83 death per 1000 live births) (4). Under-five mortality rates range from a low of 53 per 1,000 live births in Addis Ababa to a high of 169 per 1,000 live births in Benishangul-Gumuz. Under-five mortality is also relatively high in Affar, Gambela, and Somali (4).

Under-five mortality in SNNPR is among the highest in the country with 116 deaths per 1000 live births. Child, infant, post neonatal and neonatal mortalities in the Region were 41, 78, 41 and 38 per 1000 live births, respectively (4). Being home to a wide variety of culturally different ethnic groups, mortality rates and child care practices in SNNPR are expected to vary from place to place.

A relatively recent study at DSS site of Butajira, central Ethiopia, reported an infant mortality rate of 62/1000 live births (53), though its main objective was not to assess the magnitude of infant mortality. In another DSS site based study done in Dabat, Northern Ethiopia, the risk of infant death was 93.5 per 1,000 live births, whereas under-five mortality was 130 per 1,000 live births (61).

Another community based study in the northern part of the country reported neonatal, post neonatal, infant, child and under five mortality rates of 37, 30, 67, 33 and 99 per 1000 live births respectively (62). A DSS based study in the South Western part of the country also reported neonatal and infant mortality rates of 38 and 76.4 per 1000 live births, respectively (55). No study was found which assessed the magnitude and determinants of under-five mortality in the current study area. However, one study which assessed maternal and neonatal mortality rate only, in one of the district of Gamo Gofa Zone, reported a neonatal mortality ratio of 27 per 1000 live births (63). Overall, Ethiopia has shown progress in the reduction of under-five mortality in the last two decades. However, under-five mortality rate is still among the highest in the world and that warrants sustained interventions to enhance reduction beyond the MDGs.

1.4.2. Determinants of under-five mortality

1.4.2.1. Socioeconomic-demographic and environmental contamination related characteristics and under five mortality

It is generally expected that the wealth status of a household is inversely associated with childhood mortality (64). Socio-economic factors were also reported to be important determents of child survival (64). Besides, expansion of public health system, mainly as a result of implementing a program of primary health care; access to safe drinking water; the presence of sanitary facilities and good quality housing were reported to be important determinants of childhood morality (64).

Access to safe drinking water and improved sanitation facilities are generally accepted as some of the most important household characteristics to reduce infant and child mortality (65). It is also assumed that type of toilet used by the children has a strong association with mother and child health behavior. The study by Mondal and his colleagues (66) indicated that both neonatal and child mortality rates were 29.90 percent and 32.00 percent, respectively, lower among the households with access to sanitary latrine than that of the households without access to such facilities.

In the study by Kembo et al (28), infants born to mothers in households with access to improved toilet facilities were associated with a 38 percent lower risk of dying in infancy compared to those born to mothers in households without access to such facilities. In the study, although the odds ratios for piped drinking water and flush toilet were in the expected direction they were both not statistically significant. It was observed in a study done in Bangladesh that, awareness of good hygiene and water storage practices were associated with a decreased risk of diarrhea mortality (67).

Household air pollution from solid fuels (wood, dung, crop residues, charcoal and coal) used in simple stoves for cooking and heating, is recognized to be a risk factor for several health outcomes with important consequences for child survival (68, 69). However, a systematic review and meta-analysis of five studies concluded that even though overall negative impact of household air pollution on child survival was observed, the heterogeneity of the studies precluded a reliable estimate for mortality impact of household air pollution (70).

The total number of household members (household size) may also influence infant and child mortality. The expected effect of this variable is not uniform or clear. A larger number of household members could imply higher fertility levels and a fiercer competition for resources. But a larger number of potential caregivers residing in an extended household may decrease the risk of mortality. This is evidenced by a study by Uddin et al (71) and a review by Vos et al (72). In contrast, lack of significant association between household family structure (nuclear vs extended family) and infant mortality was reported by a study which analyzed recent Demographic and Health Survey (DHS) data from eight sub-Saharan African countries (73). Household family structure could be a proxy indicator of household size.

Maternal demographic characteristics such as maternal marital status and ethnicity are shown to have significant association with childhood mortality. For example, a study in Ghana found that, women who were married had a 27% less likelihood of experiencing under-five death than those who were single, divorced or widowed (74). Another study which analyzed survey data from 11 countries from Africa showed a significance difference in under-five mortality among ethnic groups of all the countries (75). This could be because of economic inequality and differentials in use of health care services by different ethnic groups of the countries.

However, such conclusion was not made by other studies. For instance, a study in Indonesia reported insignificant association between maternal marital status and neonatal mortality (76). Maternal ethnicity and religion were reported not to be significantly associated with childhood mortality in a study which analyzed DHS data of Zimbabwe (28).

Autonomy is the ability to obtain information and make decisions about one's own concerns (77). Maternal autonomy is expected to facilitate access to material resources such as food, land, income and other forms of wealth and social resources such as knowledge, power, prestige within the family and community which in turn have effect on child survival (78, 79). Limitations to women's physical, sexual, economic, social and political autonomy is expected to affect women's decision-making processes. Women's autonomy in health-care decision-making is important for better maternal and child health outcomes (80), and useful as an indicator of women's empowerment. And more autonomous women are likely to have greater freedom to take their children to health facilities for immunizations and other preventive services, as well as curative services (80), which are likely to have impact on health and survival of children.

Within the household, the role of the mother in child feeding is central. Factors associated with maternal status, such as education, are shown to be associated with child survival (81) and child nutritional status (82). Mothers with more education are also more likely to have children with better growth (82).

The literature suggests that women’s autonomy may be one of the important social variables responsible for influencing child nutritional status, thereby child survival (79, 83, 84). However, the effect varies among different ages of children (84). While women's autonomy had no effect

on younger ages (0-35 months) children's nutrition, greater levels of women's autonomy were significantly associated with improved nutrition among older ages (3-10 years) children (83).

Mothers are more likely to use scarce resources for the benefit of their children, if they are free to do so (85, 86). Mothers with greater autonomy may also benefit in other ways that indirectly affect their children. For example, they make greater use of antenatal care (87) and contraceptives (88), despite variation in socio-economic status (87). This could impact her infant's birth weight, morbidity and her own nutritional status (89). However, the findings were not universal that, in some studies, there does not appear to be any clear correlation between women's empowerment (participation in decision-making processes) in the household and early childhood mortality (90).

It has been frequently argued that maternal education, which is assumed to be an important indicator of maternal status, is an important factor in explaining risk of infant and child mortality. Maternal education is shown to play an important role in determining child survival (66, 78, 90-92), the effect is notable among older children than neonates (90). Several hypotheses have been suggested to explain this association. It is postulated that maternal education inculcates modern health knowledge, beliefs and practices; improves the effectiveness of health behavior (feeding practices, child care etc.); and changes the mother's role within the family, enabling her to take the necessary measures to prompt child health, including effective use of modern health services (93).

A study by Kishore and Parasuraman (94) showed that there is a negative relationship between maternal work and child survival, especially for male children. In the study, the odds of dying at ages 12-47 months are significantly higher when mothers are employed; the odds of dying at ages 0–11 months are higher only if the mother is employed at home or outside the home for cash. However, a different finding was reported by Mondal et al in Bangladesh (66). The rate of infant and child mortality was higher among not working women than those of working women. The risk of neonatal death was 37.90% lower among mothers who are working than those who are not (66). Inconsistent association between work status of the mother and child survival was also observed throughout the three EDHS (2000, 2005& 2011) data (significant only in 2005 survey) (92).

1.4.2.2. Maternal and child health care services and under five mortality

There are effective maternal and child health care interventions meant to tackle maternal and child morbidity and mortality. However, they fail to derive the expected health benefits at expected level, especially in developing countries (95). This is partly because of dysfunctional health services (95). This means that the effectiveness of the interventions depends on the contexts (prevalence of the problem, existence of other correlated problems and socioeconomic status of the beneficiaries) of interventions presented to the beneficiaries. So, in some contexts, access to the interventions (a poorly functioning facility) may be equivalent to no access.

Besides the proper functioning of health facilities, distance of the health facility from the residents of the beneficiaries may have effect on service utilization which in turn have effect on child mortality. Results of a study on access to health care and mortality conducted in DSS site in Papua New Guinea demonstrated a significant increase in under-five mortality with increasing distance from the province's referral hospital as shown by stratification of the study population in to urban, peri-urban and increasingly remote rural areas (96)**.**

Childhood mortality, specifically infant mortality is regarded as a sensitive indicator of the availability, utilization and effectiveness of health care interventions, and it is commonly used for comparing health care systems**,** monitoring and designing population and health programs. Besides, total health expenditures are important contributors to health outcomes of the nations. The levels of health expenditures have been found to have statistically significant effect on infant and under-five mortalities (97)**.**

Immunization is one of the most effective child-survival interventions to date. Neonatal tetanus, whooping cough, polio and measles are among those diseases which contribute significantly to the high childhood mortality and they can be prevented through immunization services. The immunization status of children is an important factor that contributes to their chances of survival. Immunized children especially fully immunized children were shown to be less likely to die than their counterparts (66)**.** However, such conclusions were not made by other reports and studies elsewhere, in which immunization was reported to have insignificant effect on child mortality (26, 98-100)**.** In addition, the effect of immunization on child survival depends on the

context of the community, that its effect was shown to be greater in communities with low socioeconomic status (99).

Place of delivery is also an important determinant of child survival. In developing countries in general and in Ethiopia in particular, many children are believed to die owing to lack of safe delivery facilities, untrained traditional birth attendants, relatives and neighbors attend most of the deliveries at home (4), a practice that may present risk to both the mother and the newborn. It is evident from the results of studies (66, 91, 101) that survival is higher among children born in health facilities and attended by professional doctors than those born at home and attended by untrained attendants, with higher effect on older children than neonates. Place of delivery is also found to be associated with early childhood illnesses, such as neonatal tetanus (102). However, a study done in Ethiopia didn't confirm this fact that, higher proportion of cases (dead child) were born in health facilities than their counter part (alive children) (62).

Studies have also shown that utilization of antenatal care services are significant factors in the survival of children (91, 101, 103)**.** With the hope that pre-natal care improve maternal health and reduce the risk of infant mortality, WHO guidelines on prenatal care in developing countries recommend at least four prenatal visits (104). Still, the effect of antenatal care and institutional delivery service on child survival are expected to be context dependent.

Vitamin A supplementation is one of the health interventions, which is expected to have many health benefits for children together with immunization. A meta-analysis (105) and policy discussion report (106) indicate that improving the vitamin A status of children aged six months to five years reduced mortality rates in populations with at least low prevalence of clinical signs of vitamin A deficiency. The number of lives saved was greater at younger ages because of higher mortality (106). A significant relative risk was also shown for deaths attributed to diarrhea and measles, but not for respiratory infections (105, 106)**.** However, such association was not observed by another study (107). So, it is natural to expect that, the effect is context dependent based on the prevalence of these intermediate causes of mortality**.**

1.4.2.3. Child feeding and newborn care practices and under five mortality

Breast feeding is expected to have impact on both the child and mother and has long been recognized as a major determinant of infant and child health, with a shorter breastfeeding period

is increasing the risk of infant mortality. This is in spite of the presence of potential confounding factors and the reverse causation bias (108). But, others convincingly argue that even when such confounders are accounted for, the empirical evidence in favor of breastfeeding is overwhelming (109). Feeding practices are also expected determinants of children's nutritional status as many studies have shown the beneficial effects of breastfeeding on the nutritional status of children (110-112).

As a result, the promotion of breastfeeding is considered to be a key component of child survival strategies in many developing countries (113). Accordingly, WHO and others emphasize on exclusive breastfeeding during the first 6 months of life, promoting early initiation of breastfeeding within one hour of birth and continuation of breast feeding with other complementary feedings till 2nd birth day of the child (114, 115).

Promotion of early initiation of breastfeeding has been observed to have a potential effect in reducing child mortality as 16% of neonatal deaths reported to be saved if all infants were breastfed from day one and 22% if breastfeeding started within the first hour of birth (116). The study by Mondal et al (66) showed that children who are breastfed are more likely to survive than those who are not.

As breastfeeding is associated with the most common causes of child mortality, namely diarrhea and respiratory infections, the extent of effect of breast feeding on child mortality may vary from place to place, based on the prevalence of these intermediating causes of child mortality. The risk of death due to diarrhea (117-119) and respiratory infections (117, 118, 120) among none or partially breastfed infants was significantly higher than those of exclusively breastfed infants. Besides, the extent of the effect of breast feeding on child mortality also varies across the age category of the child, with younger infants deriving the greatest benefit (119, 121). There are findings however, which were inconsistent with the above results, showing no significant association between child mortality and breast feeding (55). Besides, problems with breastfeeding were not shown to have significant effect in child mortality in Africa (26, 122).

The WHO's guidelines for essential newborn care practices include: hygiene during delivery, keeping the newborn warm, early initiation of breastfeeding, care of the eyes, care during illness, immunization, and care of low-birth-weight newborns (123). However, majority of deliveries in

developing countries in general and in Ethiopia in particular take place at home by untrained birth attendants. According to the EDHS 2011, only 10% of Ethiopian children were born in health facilities (4). The latest reports also showed a slow progress in increasing the number of births assisted by skilled birth attendants, which is reported to be 15% in 2014 (124) &28% in 2016 (5). As a result, many life-saving practices are either missed or done in unwanted manner, consequently high risk home delivery and newborn care practices become more common.

In a study done in Tanzania (125), only about half of women reported drying the baby immediately after birth and about a third reported wrapping the baby within five minutes of delivery. In the study, although 95% of those women reported that the cord was cut with a clean razor blade, only half reported that it was tied with a clean thread (125). Furthermore, out of all respondents 10% reported that their babies were dipped in cold water immediately after delivery, around two-thirds reported bathing their babies within six hours of delivery, and 28% reported putting something on the cord to help it dry. The study also indicated that, skin-to-skin contact between mother and baby after delivery was rarely practiced. In the study, although 83% of women breastfed within 24 hours of delivery, only 18% did so within an hour and fewer than half of women exclusively breastfed in the three days after delivery (125).

In another study done in Nigeria (126) where 66.7% of the children were born at home, only 16.2% of women used a clean home delivery surface and the majority (98.2%) of the newborns were given a bath soon after birth. In the study, initiation rates of breast-feeding were 65.3% within one hour and 95.7% within 24 hours, indicating the high prevalence of high-risk home delivery and newborn care practices (126). In a study done in Jima, a pre-lacteal feed was given to 12.6% neonates and 50.0% were initiated on breast-feeding after 12 hours of the delivery. On-demand and frequent (> 8/day) breast-feeding was reported by 93.2% of the mothers and breastfeeding problems by 8.9% of the mothers, 58.4% of the babies were bathed within 24 hours of delivery, butter was applied to the umbilical stump in 48.7% of the home delivered babies (127). The situation is expected to be similar in the current study area. Studies showed that such mismanagements of new born, like application of butter/other substances to the umbilical wound are a risk factor for the development of complications. For example, in a study by Raza et al (102), the application of substances on the umbilical cord was found to be a risk factor for neonatal tetanus, which is one of the common causes of neonatal mortality, especially

in developing countries. The effects of newborn care practices on childhood mortality are expected to be context dependent depending on the quality of the services provided to the mothers and the newborns.

1.4.2.4. Maternal parity, birth order and birth interval and under five mortality

Many maternal and child variables, including parity, maternal age, birth interval and birth order which are expected to have association with child and maternal mortality have been studied. For example, studies showed that, age of the mother at the time of the child's birth was an important factor for under-five children survival (66). Infants born to mothers who were less than 19 years of age, or 35 or more years of age are at higher risk of dying (128, 129). It may be because of the biological complications, immaturity and babies born underweight by young mothers. In another study, mothers who were between the ages of 35 and 49 were shown to be 11 times more likely to experience under-five deaths than those below the age of 20 years (74). Similarly, a significant effect of maternal age was reported by another study in Kenya with higher risk of death among age group 32 years or more (130). However, such conclusion was not made by others that, maternal age was not significantly associated with childhood mortality (28, 55, 131).

Most of the studies in developing countries show that the length of preceding birth interval is a determinant factor that influences mortality during infancy as well as other childhood ages of life (78, 90, 132, 133). That means, short preceding birth interval increases the probability of childhood mortality. Maternal depletion is often cited as the primary mechanism responsible for the adverse effects of short birth intervals. Women with short intervals between two pregnancies have insufficient time to restore their nutritional reserves, a situation which is thought to adversely affect fetal growth, resulting in a WHO recommendation of at least 24 months spacing between a preceding birth and a new pregnancy (134).

Although similar association between birth interval and child mortality has been observed, it is argued that, short birth intervals are a consequence rather than a cause of child mortality (133). The study by Mondal et al (66) also showed that, if the preceding birth interval is longer, then the risk of death is lower among neonates. But such effect was not observed among post neonates and older children, in which higher rate of mortality was observed among those with birth intervals of 18-36 months than those with less than 18 months and greater than 36 months of

interval (66). Related inconsistent effect of short birth interval on child survival was also found across different age categories by another study, in which short birth interval has increased mortality risks in the neonatal period and at 1-6 months of age, and, to a much lesser extent at 7-23 months of age (135).

According to the hypothesis of intra-household resource competition, first born children are more likely to capture vital resources such as food and care, thereby reducing their mortality risk (72) and this idea has also been supported by the study done in Nigeria (132), in which first birth order children were less likely to die than higher order children. Similar result was also reported by Howlader et al (136), that infant and child mortality would increase as birth order increased. On the other hand, it can be argued that, first born children, who are more likely to be born to mothers at younger ages, experience a higher mortality risk than children of a higher birth order. Consequently, studies point out a U-shaped effect of birth order on child mortality. The probability of infant mortality decline after the first child and increase again for children of birth order four and higher (71, 76).

Besides, the effect of birth order on child survival varies across age of the child (90) and it was not significantly associated with child mortality in other studies (55, 62). The effect of birth order on survival mostly observed during infancy, specifically during neonatal age. In the case of neonatal mortality, the risk is 76 percent higher than the risk for birth order 2-3. For those children surviving the neonatal period, infant mortality rate increases slightly for higher birth orders. In the case of under-five mortality, fourth to sixth-order births have the lowest risk of dying before age five (90).

Maternal parity (fertility) is one of the maternal factors, which is expected to have effect on child survival. In a study by Macinko et al (100), maternal fertility was one of the factors which negatively affect child survival. However, as maternal parity is related with birth order, it is logical to expect similar inconsistent relationships between maternal parity and child mortality like that of birth order. Besides, insignificant relation between parity and childhood mortality was reported by others (55, 137).

1.4.3. Child loss and maternal mental distress

Some life events have long been studied as possible precursors to the onset of mental illnesses, because of their potential to invoke stress. Events perceived by individuals as undesirable, out of their control and outside the normal expected sequence of life tend to be followed by higher levels of psychological distress than other forms of life changes (138).

About a fifth of women with still birth were reported to have prolonged depression (17, 139) and a fifth of such mothers were shown to have post-traumatic-stress disorder in the subsequent pregnancy (140). Children in the family of such mothers were found also to be affected by mothers' mental condition due to such stressful events (141, 142).

The death of a spouse or child is one of the most stressful events that a person can experience during the course of his or her life. Some early studies of bereavement suggested that its psychological impact is relatively transient (58, 143). A thorough review of the research in this area, however, does not substantiate this view of the grieving process. Although symptoms decline with time, many investigators have reported that a significant number of the bereaved continue to show marked symptoms after six months (144), one year (145), two years (34) and 2 to 4 years (146). The effect is shown to last long, if the death is accidental (147).

The effect of child death was found to be more than that of partner death in causing mental distress. In a systematic eight years follow up study, Lundin found more evidence of persisting tearfulness and grieving among parents who had lost a child than among widows and widowers (148). The effect has also been shown to last long and the recovery from grief was associated with having a sense of life purpose and having additional children. But it was unrelated to the cause of death or the amount of time since the death (149).

There appears to be a general experience in which bereavement, particularly one's emotional response to the loss, causes negative psychological outcomes. Newly bereaved parents exhibit more depression, somatic symptoms, poorer self-esteem, and a lower sense of control in their life compared to non-bereaved parents (150). Nonetheless, not all parents continue to experience these negative symptoms over an extended period of time, though some clearly do (45).

The mental health effect of child death on parents is found to be more severe among mothers than fathers. Studies have found that mothers have an excess of depression than fathers following child loss (151, 152). This may be because mothers, more than fathers, are involved in nursing and caring for children and it is the mother who carries the child in her womb and directly feel the pain of labor.

Some trauma survivors indicate that they have gained increased coping skills, enhanced social relationships, and deepened perspectives on life as a result of their traumatic experience due to child loss (153). One potential mechanism for this effect is perceived social support. Parents who have lost a child and who report higher levels of perceived social support exhibit better psychological outcomes than bereaved parents with lower levels of perceived social support (6).

Through time the symptoms are shown to reduce after such bereavements. It has been observed that, bereaved parents have a marked reduction in the symptoms of mental illnesses over the first eight months after child death (41). Additionally, the reason for rapid recovery, includes contact with other people, including friends, parents, spouses, surviving children, and other bereaved parents (154).

In summary, stressful life events, including partner and child loss have effect on the mental health of the surviving parents. However, all life events do not invariably cause psychological disturbance. The effects are inconsistent and dependent on different situations the sufferer presented. Common mental disorders, including depression and anxiety, are more prevalent among pregnant women and mothers of infants in resource constrained settings than in high-income countries. As a result, the effect of child death on maternal mental health is expected to be context dependent. In Ethiopia, studies investigating the extent and associated factors of the problem among bereaved mothers are lacking.

1.5. Conceptual framework of the study

The Mosley & Chen's analytical framework for the study of determinants of child mortality (19) is conceptually identical to that of Davis & Blake's conceptual framework for fertility (20). Background social, economic, cultural, and health system variables influence a set of proximate determinants which in turn directly influence the single outcome variable. They define five categories of a total of 14 proximate determinants: maternal factors (age, parity, birth interval etc); environmental contamination (air, food/water/ fingers, skin/soil/inanimate objects, insect vectors); nutrient deficiency (calories, protein, micronutrients); injury (accidental, intentional); and personal illness control (personal preventive measures; medical treatment). Factors in the first four groups affect the rate at which children move from healthy to sick, whereas factors in the last group influence both the rates at which children move from healthy to sick (through prevention) and the rate of recovery (through treatment) (19).

On the other hand, they grouped the socioeconomic/distal determinants of child mortality in to three broad categories:

1) Individual level variables: individual productivity (skills (measured by educational level), health time of the mother and the father); traditions/norms/attitudes (power relationship, beliefs about disease causation, value of children, food preference)

2) Household level variables: Income/wealth: a variety of goods, services and assets in the household influence child survival through operating the intermediate factors. Income/wealth could affect child wellbeing through availability of: food (quality and quantity), water (quality and quantity); housing (size and quality); fuel/energy; transportation; preventive care; information etc.

3) Community level variables: some of the community level factors identified by Mosley & Chen include:

- ✓ Ecological settings (climate, soil, rainfall, temperature, altitude, and seasonality)
- ✓ Political economy (political institution and health system variables) and availability of health service are crucial determinants for child survival
- ✓ Physical infrastructures (road, electricity, sewerage, water, telephone system etc.)

The conceptual framework for the current study has been adapted from the Mosley & Chen's analytic frame work (19) and summarized as follow in figure 1. N.B. Among proximate determinants, injury was not assessed in this study. The framework is also extended to accommodate maternal mental distress. In the framework, it is postulated that maternal mental health status affects child mortality and that in turn affects maternal mental health status. Other factors are also postulated to affect maternal mental distress and vice versa (figure 1).

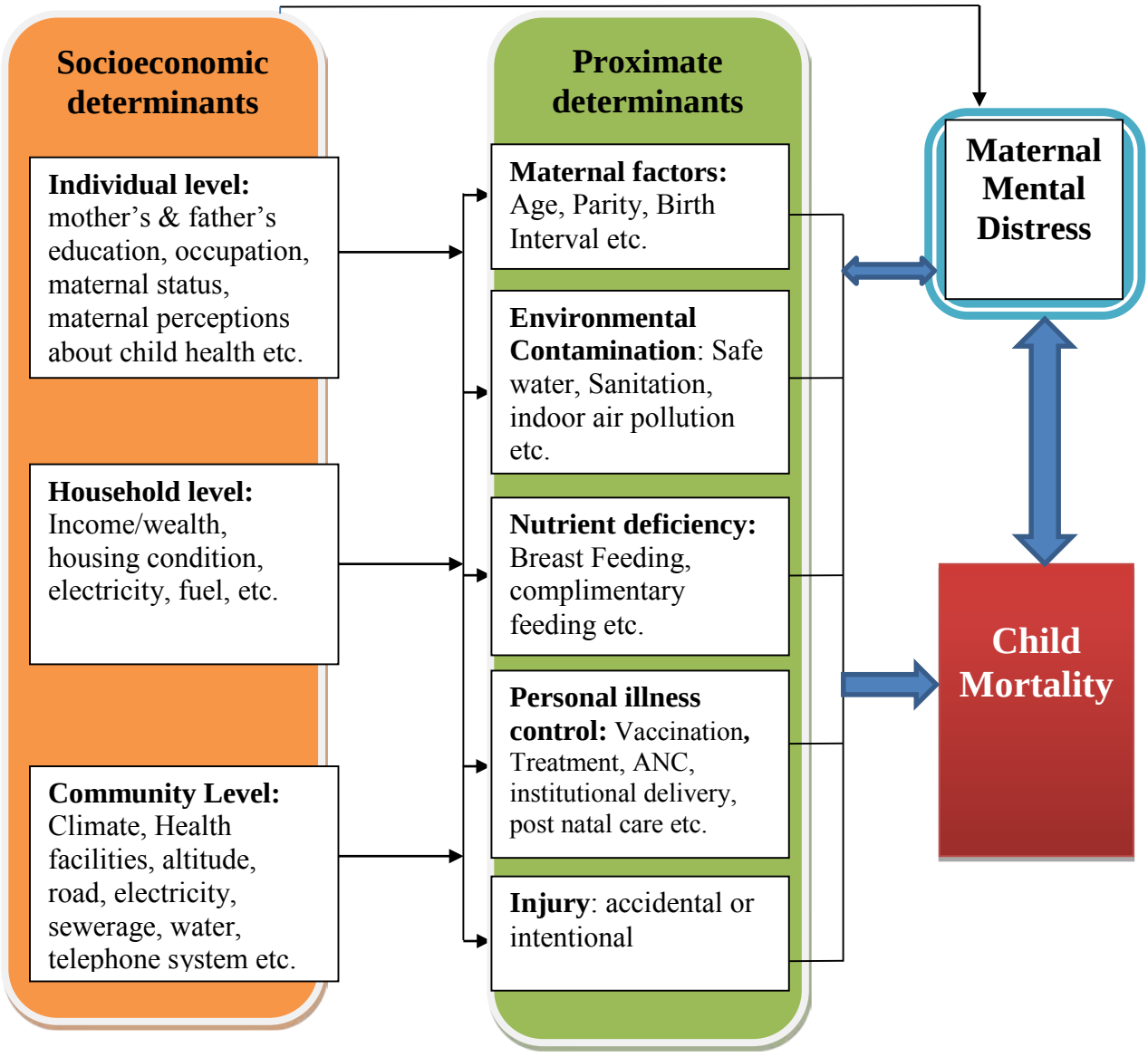

Figure 1: Conceptual framework showing the operation of distal and proximate determinants of under-five mortality and its relation with maternal mental distress (adapted from Mosley & Chen's analytical framework for the study of determinants of child mortality)

2. Objectives of the study

2.1. General Objective

To assess the magnitude and determinants of under-five mortality and its association with maternal mental distress in Gamo Gofa Zone, Southern Ethiopia

2.2. Specific Objectives

1. To determine the magnitude of under-five mortality in the area
2. To identify determinants of under-five mortality in the community
3. To assess the correlation between child death and maternal mental distress

3. Methodology

3.1. Study area

The study was conducted in Gamo Gofa Zone, which is one of the 14 Zones in the Southern Nations Nationalities and People's Region (SNNPR). The Zone has 15 Districts (Woredas) and two Town administrations. Arba Minch Town, the Capital of Gamo Gofa Zone, is 502 kilo meters (Kms) south of Addis Ababa. Gamo Gofa Zone is a zone with two Lakes (Lakes Chamo and Abaya) (figure 2). The Zone is known for its banana, apple and fish production, which may impact child nutrition and survival. There were three hospitals and 68 health centers providing health services for the population during the study period. In 2014, the total population of the Zone was projected to be 1,901,953 (with 943,834 males and 958,119 females, 285,043 Urban (15%) and 1,616,910 Rural (85%) residents) (155).

Arba Minch Zuria District was selected for the study, since it was the study site for the Arba Minch Demographic Surveillance System (DSS) which is relatively new in the country. As the District has three climatic/ geographic zones (Dega(high land), Woina dega (mid land) and Kolla(low land)), it is suitable to represent population of different agro ecological zones. The District lies on 168,712 square kilometers and constitutes 29 kebeles (lowest administrative units in Ethiopia). The total population of the District was projected to be 185,302 (with 92,680 males and 92,622 females) in 2014. Arba Minch Town, which is the capital of the Zone, is included to represent the urban population of the Zone. The total population of the Town was projected to be 135,452 (with 68,132 males and 67,320 females) (155). The Town was divided in to 11 urban kebeles.

The Arba Minch DSS was established in 2009 in one of the Districts in the Zone (Arba Minch Zuria District), which was part of the current study. Arba Minch DSS is based in nine kebeles of the District. It was established by having base line survey/census of the kebeles during July 01-September 30, 2009. Since then, it has been tracking information on vital events (birth, death, migration, marital status, etc.) continuously. The total population of the DSS was 59,875 with 12,241 females in the reproductive age (15-49), 9,825 under-five and 2,388 children under one year of age.

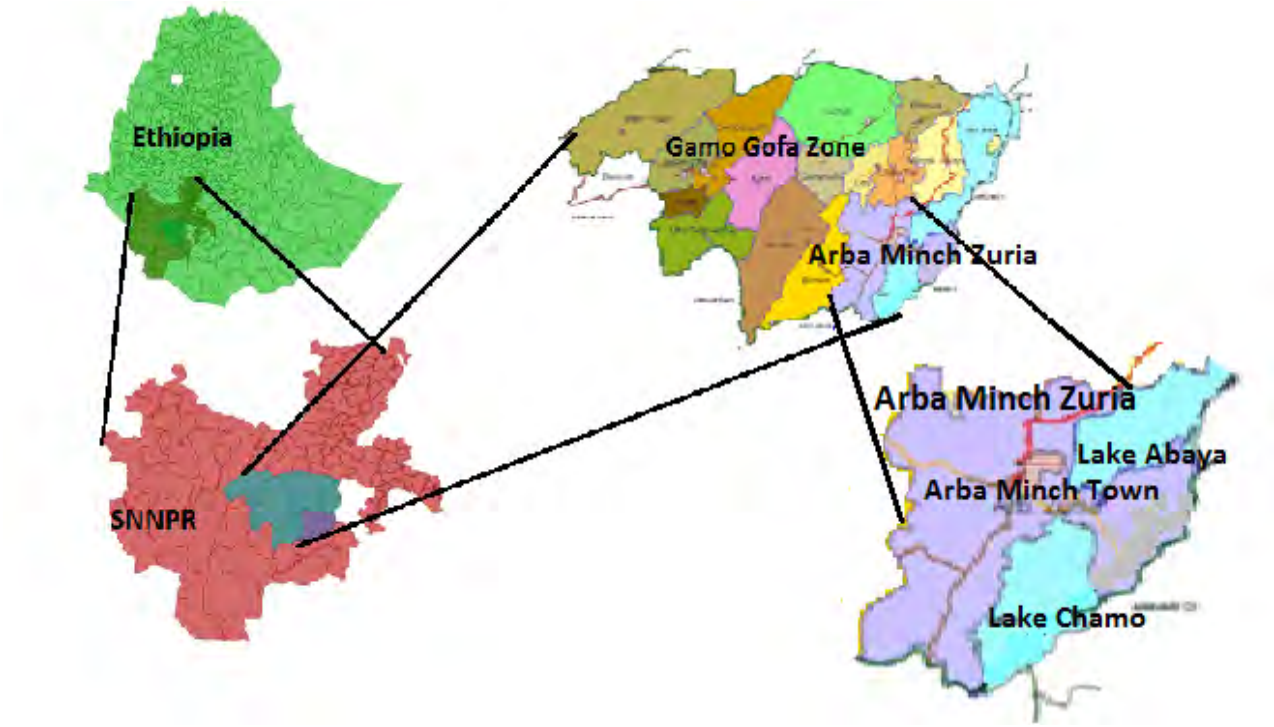

Figure 2: Map of the study area (Arba Minch District and Arba Minch Town), 2014.

Source: Adapted from the Department of Finance and Economy Development of Gamo Gofa Zone

3.2. Study Designs and Period

Mix of methods to address each of the specific objectives were applied. Accordingly, simple cross-sectional, matched case control and comparative cross-sectional study designs were implemented. The study was conducted in 2014. The first objective was addressed by a cross-sectional (prevalence) study design, which was conducted as part of a base line assessment (a census of the selected kebeles) to identify cases/exposed and controls/unexposed for the subsequent case control and comparative cross-sectional designs. The second objective was addressed by matched case control study with a case of under-five children who died during the study period and two age matched controls of live children in the same kebele. A comparative cross-sectional study design was conducted to address the third objective by comparing the prevalence of mental distress among mothers with under-five child death and among those without. For the later design, mothers with under-five child death were considered as exposed and those without as unexposed. The summary and sequences of the study designs are presented in figure 3 below.

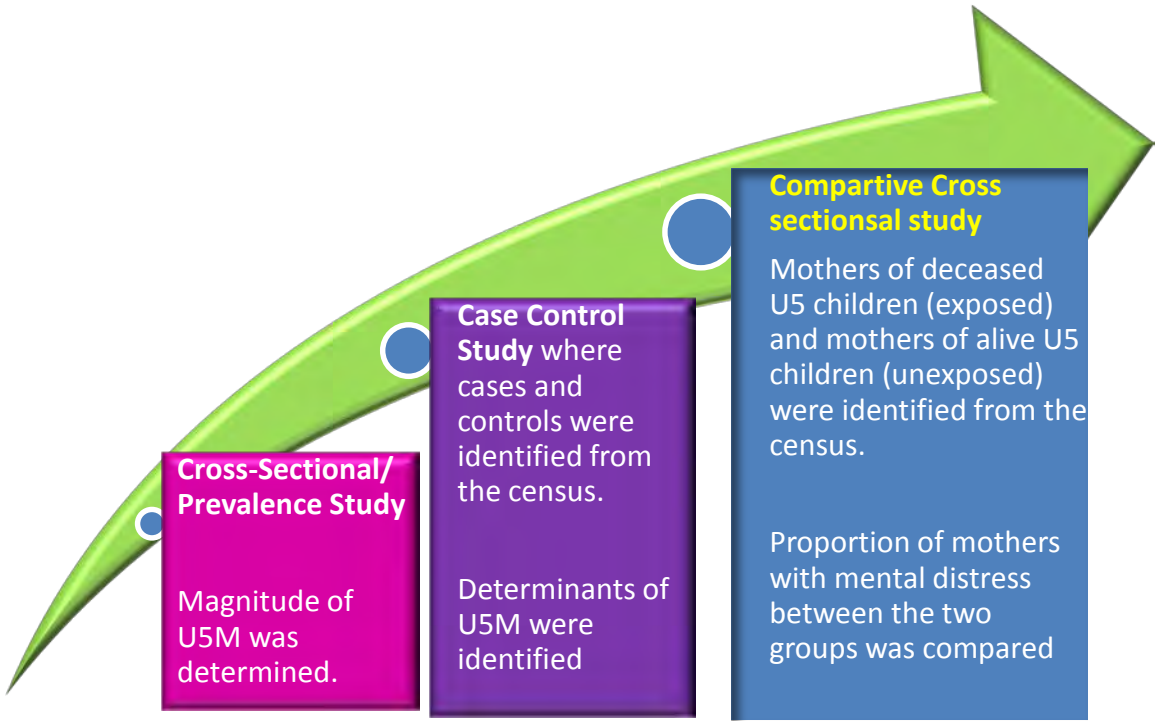

Figure 3: Summary and sequences of the study designs, Gamo Gofa Zone, 2014

3.3. Source and study population

The source population was all under- five children and mothers' of under five children in the study area. The study populations for the prevalence study were all children born between September 01, 2007-September 30, 2014. The study population for the case control study consisted of cases of under five-children who died between March 01, 2011 and September 30, 2014 and randomly selected two live controls of under-five children born with in one month time in the same locality as the cases. The study population for the comparative cross-sectional study consisted of exposed mothers of mothers whose under five-children died in the period between April 01, 2011 and September 30, 2014 and unexposed were two mothers with live children who were matched for date of birth of the index child (born within one month) and living in the same kebele. The time spans mentioned above were opted for, with the assumption that they could enable us to have adequate sample without compromising the information sought to be generated (minimum recall bias).

Inclusion criteria: All children (alive and dead) together with their respective mothers live-born between September 01, 2007 and September 30, 2014 in non DSS kebeles and between July 01, 2009 and September 30, 2014 in DSS kebeles were included in the studies of this thesis.

Exclusion criteria: Still births were not included. For the mental health questionnaires, mothers were excluded if they could not be located/ communicated or died.

3.4. Sample size determination

The sample size required for the first objective (prevalence study) was determined by using the following formula for a single population proportion by considering the prevalence of under-five mortality to be 88/1000 live births (4). By taking 95% confidence level and 1.5% margin of error, the minimum required sample size for the study was 1371. By applying a design effect of 1.5 and adding 5% to compensate for non-response, a total of 2158 under five children were required. However, all (20161) children who had been identified during census of the selected kebeles and Arba Minch DSS database were included in the analysis to increase the precision and be able to estimate other categories of childhood mortality rates.

$n= [(Z\alpha/2)^2\ p\ (1-p)]/d^2$

Where:

P=the prevalence of <5 mortality

Z=a standard score corresponding to 95% confidence level (1.96)

d=the margin of error (1.5%)

n=the required sample size

The sample sizes for the second and third objectives were calculated using the following formula (156, 157) using the statcalc command of Epi info 7 statistical software package.

$$n_i = \frac{[Z_{\frac{\alpha}{2}}\sqrt{(r+1)\pi Q} + Z_{\beta}\sqrt{rP_iQ_i + P_cQ_c}]^2}{r(P_i - P_c)^2}$$

Where:

n_i = the required sample size for cases/exposed

P_c = estimated proportion of exposure (independent variable) among controls for the case control or estimated proportion of outcome among unexposed (alive) for comparative cross-sectional study, as appropriate.

P_i = estimated proportion of exposure among cases for the case control or estimated proportion of outcome among exposed for comparative cross-sectional study as appropriate.

$\pi = \frac{P_i + rP_c}{r+1}$

$P_i = \frac{P_c OR}{(1 + P_c(OR - 1))}$ Where OR=Odds Ratio

Q =1-π; Q_i =1-P_i and Qc =1-P_c

$Z_{\alpha/2}$ = 1.96 (standard score corresponding to 95% CL (two side))

Z_β = 0.84 (standard score corresponding to 80% power)

r=ratio of controls to cases or ratio of non-exposed to exposed =2

n_c =the sample size for controls/unexposed=r x n_i

For the case control design, the prevalence of exposure (selected determinants) among controls and cases were estimated from previous studies (22, 23, 62, 158-160) or calculated from data available from Arba Minch DSS database. Then, the sample size required for detecting an odds ratio (OR) with a two-sided alpha value of 5% and a power of 80% was determined for all main exposure variables with control to case ratio of 2. Then, the maximum sample size was taken. Accordingly, the sample size corresponding to home delivery was taken. Accordingly, a minimum of 241 cases and 482 controls were required. By applying a design effect of 1.5 (161) and adding 5% to compensate for non-response, a total of 380 cases and 760 controls were required. The details of the estimations, indicators and sample size required for all main variables are summarized in table1 below.

Table 1: Variables and their corresponding indicators used for sample size calculation for the case-control design, Gamo Gofa Zone, 2014

Exposure/outcome variables*	% of control exposed	%cases exposed	No. cases	No. controls
Maternal &child Health services				
Lack of ANC (158)	20.6	36.5	92	184
Home delivery (Arba Minch DSS database)	87.2	93.8	241	482
Lack of vaccination (159)	27	66	18	36
Child feeding and newborn care				
Lack Exclusive breast feeding (158)	14.1	28.1	96	192
Parity, birth order& birth interval				
Parity>=5 (160)	23.6	36.7	141	282
Birth interval<24m (62)	13.3	28.8	78	155
Maternal status				
Maternal illiteracy (62)	49.7	78.1	34	67
Low participation in decisions (159)	24	39	110	220
Household characteristics				
No latrine facility (62)	31.8	49.0	94	188
Lack of safe water supply (23)	41.5	58.5	101	202
Low wealth index (22)	73.9	85.1	156	312

*In all cases a confidence level of 95% and a power of 80% were used

For the comparative cross-sectional study, the prevalence of mental distress among unexposed (mothers without child death) was estimated from a study conducted among postnatal mothers in the country (162). Then, the sample size required for detecting an odds ratio of 1.7 with a two-sided alpha value of 5% and a power of 80% was determined with non-exposed to exposed ratio of 2. Accordingly, a minimum of 219 exposed and 438 unexposed were required. By applying a design effect of 1.5 and adding 10% to compensate for non-response, a total of 362 exposed and 724 controls were required. The detail is summarized in table 2 below.

Table 2: Summary of sample size calculation for comparative cross-sectional study design, Gamo Gofa Zone, 2014

Maternal Mental Health	%of outcome in unexposed	OR	CL	Power	No. exposed	No. un-exposed	Total
Prevalence of mental distress (162)	19.8%	1.7	95%	80%	219	438	657

3.5. Sampling technique

Arba Minch Town and the Arba Minch Zuria District were selected purposely out of the 15 Districts and two Town administrations of the Zone. Besides its being the study site of Arba Minch DSS, Arba Minch Zuria District is suitable to have representative sample of the Zone as it comprises of kebeles distributed in different agro ecological and climatic conditions (Dega(high land), Woina dega (mid land) and Kolla(low land)). Arba Minch Town is the capital of the Zone and home to population from different districts of the Zone. All the 11 kebeles of Arba Minch Town and the nine kebeles of the Arba Minch Zuria District which are part of the Arba Minch DSS were included (initially, those kebeles were selected randomly out of 29 kebeles in the District). Additional 11 kebeles from those kebeles which were not part of the Arba Minch DSS were selected randomly. Accordingly, 31 kebeles from the two Districts were included in this study (11 from Arba Minch Town and 20 from the Arba Minch Zuria District).

Then, a census of the 11 non-DSS kebeles of the Arba Minch Zuria District and 11 kebeles of Arba Minch Town had been conducted in order to identify all children (alive and dead) born between September 01, 2007-September 30, 2014. The children were followed retrospectively by asking the respondent about whether the child was alive or dead at the time of the survey. If the child was dead, the date of death was recorded.

As the Arba Minch DSS has been tracking all births and deaths since its establishment in 2009, children born between August 01, 2009 and September 30, 2014 in Arba Minch DSS kebeles were tracked from the database of the DSS. Therefore, data since 2009 were tracked from all the 31 kebeles and the data since 2007 were tracked only from the 22 kebeles. The sampling procedure for the census, which was the basis for the other consecutive designs, is summarized and presented in figure 4 below.

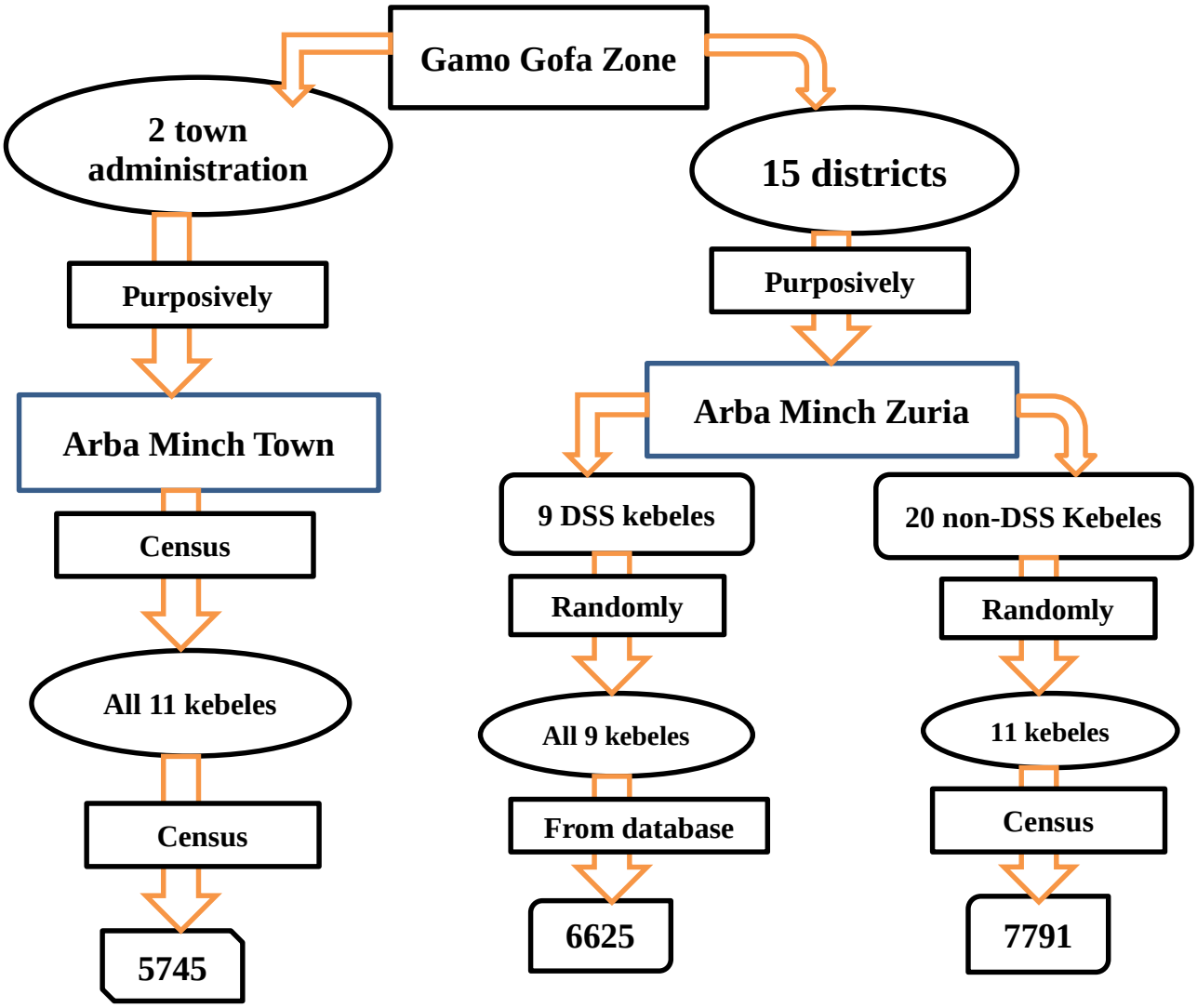

Figure 4: Schematic presentation of the study districts and kebeles and their selection procedure, Gamo Gofa Zone, 2014

Then, for the case control study, 383 cases that fulfilled the inclusion criteria (children who died between March 01, 2011 and September 30, 2014) were identified from the census and the Arba Minch DSS. And all of them with their corresponding matched (for age and kebele of residence) and randomly selected 766 controls were approached. For the comparative cross-sectional study, all mothers who lost under-five child between April 01, 2011 and September 30, 2014 were taken as exposed and two mothers with live child who were matched for each of the exposed for

date of birth of the index child (within the same birth month) and were living in the same kebele were taken as unexposed.

3.6. Data collection procedure and the instruments

Pre-tested Amharic census form was utilized for data collection during the census. Variables in the questionnaire included: sex of the child, date of birth of the child, whether the child was alive or dead, if dead, date of death and other identifiers (identification number for the child and the mother, District name, kebele name, house number etc.). Date of births and deaths were determined from child immunization cards or health post registers (if available) or using local calendar (historical land marks) with the help of the Health Extension Workers (HEWs) working in the kebele. HEWs know the households in their respective kebeles very well, as they are permanent resident of the kebele and register all households in the kebele and events that are happening in those households as part of their day to day activities. For the case control and the comparative cross-sectional studies, a quantitative questionnaire consisting of socioeconomic and demographic, environmental contamination related, health service utilization, child feeding and new born care related, reproductive characteristics, etc of the mothers was developed based on literatures. The questionnaires were developed in English and translated to Amharic, then back translated to English to check for their consistency. Finally, the Amharic Versions were used for data collection.

Common mental disorder (CMD) symptoms were assessed using the World Health Organization's (WHO's) self-reporting questionnaire (SRQ-20) (163). This 20-items questionnaire asks about depressive, anxiety and somatic symptoms present in the preceding month. The SRQ initially consisted of 25 questions (20 related to neurotic symptoms, four concerning psychotic symptoms and one asking about fits (convulsion)). Because of validation problems the SRQ-25 has, SQR-20 was used as it was validated in many countries, including in Ethiopia. This instrument has been used in previous Ethiopian community-based studies (164-167), and was validated for use in perinatal women in Ethiopia (168). A cut-off score of ≥ 6 was shown to have convergent validity as an indicator of CMD (168). The same cut-off point was used in this study and interview administered method using the Amharic Version of the questionnaire was employed.

At least two data collectors (grade 10 or above) per kebele were recruited and trained on the procedure. Four master degree holders (in Public Health) supervised the data collection process. The principal investigator strictly followed the data collection throughout the process. Besides, additional data were sought from the kebele administrations and health posts through reviewing documents and/or interviewing the kebele officials or HEWs to determine some characteristics of the kebeles. Data with regard to dead and alive children from Arba Minch DSS kebeles were obtained from the DSS's database.

3.7. Measurements and Operational definitions

3.7.1. Measurements

3.7.1.1. Dependent variables

- ✓ For the case control study: mortality status of the index child (dead or alive)
- ✓ For the comparative cross-sectional study: Presence of mental distress or not (on SRQ20, yes to greater than or equal to 6 of the questions)

3.7.1.2. Independent variables

- ✓ For the case control study: Socio economic and demographic characteristics, environmental contamination related factors, personal illness control related characteristics, child feeding and newborn care practices and other maternal and child related characteristics such as parity, birth interval, birth order etc.
- ✓ For the comparative cross-sectional study: **Primary:** mortality status of the child. **Secondary:** socioeconomic &demographic, health service utilization, reproductive characteristics of the mothers

3.7.2. Operational Definitions

- ✓ **Having mental distress:** Those mothers who answered 'yes' to six questions or more on the SRQ-20.
- ✓ **Exclusively breastfed:** children who breast fed exclusively for the first 6 months of life
- ✓ **Predominantly breast feeding:** breast feeding plus water and water-based drinks, fruit juice, ritual fluids but not non-human milk, food-based fluids

- ✓ **Partial breast feeding:** breast feeding with other additional food (including non-human milk, food-based fluids)
- ✓ **Cases:** Under five children who died between March 01, 2011 and September 30, 2014
- ✓ **Controls:** Under five children born with in one month of age of matched case and who were alive and living in the same kebele as that of the case during the study period
- ✓ **Exposed:** Mothers whose children died between April 01, 2011 and September 30, 2014
- ✓ **Unexposed:** Those mothers whose child was alive during the study period (matched for date of birth of the index child and living in the same kebele as that of exposed)
- ✓ ***Wealth index:*** was computed using principal component analysis (PCA) of reported ownership of household assets such as radio, television, bicycle, livestock, etc and proxy indicator of living standard variables, like number of rooms the living house had, the roof of the house, whether the house is private or rental etc. (for urban and rural separately). Then, the wealth status was categorized in to three groups and ranked from poorest to wealthiest.
- ✓ ***Maternal power:*** was computed using PCA of eight variables which measure decision power of the mother in the household (decision on maternal and husband income, on purchase and on visiting relatives or health facility (1 was assigned if the response favors maternal power (eg. if mother decides or jointly with her partner 1 was assigned) other wise 0), perception on wife beating (0 if she justifies to at least for one in the list), if ever beaten by husband (0 if ever beaten), if husband assist in house chores (0 if husband didn't assist)). Then, the maternal status was categorized in to three groups and ranked from poor, average to good.
- ✓ **Neonatal mortality:** is the probability of dying within the first 28 days of birth.
- ✓ **Post-neonatal mortality:** the probability of dying after the first month of life but before the first birthday
- ✓ **Infant mortality**: is the probability of dying between birth and the first birth day.
- ✓ **Child mortality:** is the probability of dying between the first and the fifth birth day.
- ✓ **Under five mortality:** is the probability of dying with in the fifth birth day.

3.8. Data processing and management

The data were edited, coded, entered into computer and cleaned using Epi Info Version 3.5.1 and analysis was performed by open-epi version 2.3 and STATA 11 as appropriate. The daily collected data were transferred to the Arba Minch University and locked in a secure cabinet which was arranged in the compound of College of Medicine and Health Sciences of the Arba Minch University. The data were entered into Epi info by two data encoders after having training /orientation on the template, the procedures for insuring the quality of the data during data entry and the importance of quality of data. They were also expected to identify incomplete and inappropriate data and communicate to the principal investigator at this stage too. This was strictly followed and checked by the principal investigator on daily basis.

3.9. Data analysis

For the first objective, descriptive analyses with frequency and cross tabulation with the corresponding confidence interval or chi-square with p-value were made. As we collected data on complete live birth histories of all mothers within the last seven years before the survey, we applied a direct method to estimate mortalities. Accordingly, birth cohort method was applied to determine overall level of childhood mortalities (only deaths of children born during the study period were included in the numerator). Whereas, death cohort (conventional) method was used for trend analysis (deaths of children born prior to the target year may be included in the numerator of that year). Using open-epi version 2.3, Extended Mantel-Haenszel chi square for linear trend was performed to assess presence of linear trend in mortality through the study period.

For the second objective, to determine predictors of under-five mortality (distal and proximate factors), conditional logistic regression was conducted. As outlined by the conceptual framework, the distal determinant factors appear to have hierarchical nature. However, because of the matching during the design stage, our data didn't show this nature. This was demonstrated by, the between (clusters') variance of nearly zero value and lack of significant result for the random effect model in multilevel analysis.

The conditional logistic regression analysis was done consecutively/ hierarchically (169). First, the association between the distal factors and childhood mortality was determined. Then, those

distal factors which were significant at p-value of 0.1 were controlled in the models for assessing the association between proximate variables and the outcome. The models for proximate variables was developed for each category of the proximate variable categories (e.g. for environmental pollution factors, maternal and child factors, variables related with child feeding and new born care and variables related with disease control practices). Sex of the child was also included in all models as it was shown to be significantly associated with childhood mortality in the current and other previous studies. Enter method was used to select variables for all the models. Further, sub-group analysis was conducted to identify any unique determinants in the three categories of the kebeles (DSS, non-DSS rural and urban).

For the third objective, both descriptive and analytic analyses were carried out. To determine the association between child death and maternal mental distress, conditional logistic regression was conducted with mental distress is coded as a binary outcome (present or absent). Using open-epi version 2.3, Extended Mantel-Haenszel chi square for linear trend was performed to assess the trend in the level of mental distress among mothers with child loss as time went on.

In all cases, weighted analyses were conducted to account for the unequal selection probability of the sample. The sampling weights were calculated using the following notion: by determining sampling probability at three stages (District, kebele and individual levels). P(k^{th} individual in j^{th} kebele in i^{th} District being selected) = P(i^{th} District being selected)P(j^{th} kebele selected| i^{th} District is selected)P(k^{th} individual selected| j^{th} kebele is selected (170, 171).

Model diagnostic was conducted following each model using different STATA commands: For example, presence of specification error in the link term (logistic) or predictors was assessed with linktest command. Besides, the goodness of fit of the models was assessed by log likelihood chi-square test of the null hypothesis of no overall effect of predictors (compare empty model with current model) on the outcome and Akaike Information Criterion (AIC) using estat ic command. With regards to other model diagnostics, as STATA 11 don't allow model diagnostics such as assessment of residuals, leverages and influence after robust analysis such as weighting, we did it following un-weighted conditional logistic of each model. Then we removed those influential observations (having large dbeta) and re-run the weighted conditional logistic regression and assessed if any substantial change on the values (B or odds ratios). Except for

minimal change in the values the omission of the influential observations didn't bring substantial change on significance or the odds ratio values.

Presence of interaction/effect modification was also assessed for suspected variables in all models. In all cases, the models without interaction terms were considered, as significant interaction/ effect modification of the selected variables was not observed in all models. Collin command was used to assess presence of multicollinearity among predictors. Tolerance value <=0.1 or variance inflation factor (VIF) of greater than or equal to10 were taken as an indicator of presence of multicollinearity.

3.10. Data Quality Assurance

The questionnaires were pre-tested in kebeles which were not part of the study. The aim of the pre-testing included assessing the clarity of the questions, presence of similar understanding of the data collectors in the procedures in the real situation and identifying any unseen situations the data collectors might face in visiting the households and filling the questionnaires. After the pre-testing, discussion was held with the supervisors and data collectors and un-clarities/amendments were resolved/made as required.

Besides, a standard and validated WHO's (SRQ-20) was used. Trainings were given to data collectors and supervisors on the questionnaires and the procedures. The data collection process was strictly followed up. All collected data were checked every day for their completeness, clarity and consistency by supervisors and the principal investigator. Any unclear and ambiguous data were corrected by recollecting data from actual study population by going back to the field, while minor errors were corrected by the principal investigator as deemed necessary. About 5% of the households were re-visited by the supervisors/principal investigator to check for the validity of the information collected by data collectors. Then, data were cleaned and checked before data entry and analysis. Besides, double entries of 10% of the questionnaires were made.

3.11. Ethical considerations

Ethical approval: Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. The proposal also went through the approval of School of Public Health (Addis Ababa University) research ethics committee. Letter was written to all concerned bodies (Gamo Gofa Zone Health Department, Arba Minch Zuria District and Arba Minch Town Health Offices and administration of all the kebeles) and permission was secured at all levels.

Informed consent: After explaining about the purpose, the possible benefit of the study, risks associated with involvement in the research, the right of the study participants to withdraw from the interview at any time (if they want) and confidentiality of the data, informed consent was obtained from each respondent.

Benefits: There were no direct benefits or incentives for the participants if they participate in this research, however, the results of the study have been expected to help service providers, policy makers or managers working in the area to provide quality services and to have informed decision for the wellbeing of the community, including the study participants and their children.

Possible risks: Except for the time the participants devoted to respond the questions in the questionnaires and the discomfort they might felt owing to refreshment in their memories of the dead child, there was no direct risk/harm related to involvement in this study.

Confidentiality: To assure confidentiality of responses, anonymous interviews were conducted. Besides, the daily collected data/questionnaire were transferred to the Arba Minch University and locked in a secure cabinet.

Privacy: All possible measures were considered to ensure privacy of the participants. This was attained by conducting all interviews in a private and safe place (in the absence of others).

3.12. Summary table of study objectives and methods

S. No.	Objectives	Source population	Design	Sample size	Analysis	Tool
1.	To assess the magnitude of under-five mortality in the community	Under five children in the community	Cross-sectional /census	2158 were required but all (20161) children who were identified by the census and the Arba Minch DSS were included	Descriptive and Bivariate analysis for few variables	Census questionnaire/form
2.	To determine determinants of under-five mortality in the community	Under five children in the community	Matched case control	381 cases 762 controls	weighted conditional logistic regression	Quantitative questionnaire
3.	To determine the association between child death & maternal mental distress	Mothers of under-five children	Comparative cross-sectional	356 exposed 712unexposed	Descriptive analysis& weighted conditional logistic regression	SRQ-20 and Quantitative questionnaire

4. Results

4.1. Magnitude and trends of under-five mortality

4.1.1. Basic characteristics of the study subjects/kebeles

Overall, 13,536 children born between September 2007 and September 2014 were identified from the census of 11 kebeles of the Arba Minch Town and 11non-DSS rural kebeles of the Arba Minch Zuria District. Additional data from 6,625 children born between August 2009 and September 2014 were obtained from the Arba Minch DSS database. A total of 20,161 children were included for this analysis. Accordingly, 6,625 (32.9%), 7,791 (38.6%) and 5,745(28.5%) of the children were from DSS sites, none DSS rural kebeles of Arba Minch Zuria District and Arba Minch Town, respectively.

Majority (27/31) of the kebeles had all-weather road. More than half (19/31) of the kebeles were more than 10killo meters (kms) away from the serving hospital in the area (Arba Minch Hospital). Except one kebele, all the 30 kebeles were within 10kms from the nearby health center. Majority (23/31) of the kebeles' staple food was maize. Most (19/31) of the kebeles were malarious. All kebeles had at least one HEW working in the kebele during the study period. Almost all (29/31) had at least two HEWs working in the kebeles. A maximum of 4 HEWs were found in some kebeles. In about half (14/31) of the kebeles, HEWs were providing delivery service at home or in the health post during the study period.

Overall, 10,375 (51.5%) of the children were females giving a male to female ratio of 1:1.06. Majority (14,416 (71.5%)) of the children were from rural kebeles. Five hundred eighty five (2.9%) of the children were neonate. Three thousand eight hundred twenty five (19%) of the children were less than one year old. Majority (13,512 (67.0%)) of the children were from kola (low land) kebeles. Majority (71.5%) of the children were living more than 10kms away from Arba Minch hospital. Whereas, 95.2% of the children were living within 10kms distance of the nearby serving health center (Table 3).

Table 3: Characteristic of the children/ kebeles for magnitude of mortality, Gamo Gofa Zone, 2014

Characteristics		
Distance from Arba Minch Hospital in KM of the household	**Frequency**	**Percent**
<=10km	5745	28.5
>10KM	14416	71.5
Distance from Nearby Health center in KM of the household		
<=10Km	19189	95.2
>10Km	972	4.8
Sex of the child		
Male	10375	51.5
Female	9786	48.5
Age category of the child		
Neonate	585	2.9
Post Neonate	3240	16.1
Infant	3825	19
Child	16336	81
Under-five	20161	100
Kebele category of the child		
DSS-Rural	6625	32.9
Non-DSS Rural	7791	38.6
Urban	5745	28.5
Climatic/agro-ecological Zone of the child		
Kola(low land)	13512	67.0
Weyna Dega(mid land)	2864	14.2
Dega (high land)	3785	18.8

4.1.2. Mortality Rates

4.1.2.1. Overall description of un-weighted mortality

As depicted in figure 5, out of 20,161 children identified through the census of the 22 kebeles and the Arba Minch DSS, 815 died before their fifth birth day, providing an overall un-weighted under five mortality rate of 40/1000 live births. Of those, 282 died within the first seven days of birth, giving an un-weighted early neonatal mortality rate of 14/1000 live births. Sixty six of the children died after seven days but within one month of age, giving an un-weighted late neonatal mortality rate of 3/1000 live births. Accordingly, overall un-weighted neonatal mortality (early

plus late neonatal) was 17/1000 live births. Three hundred of the children died after one month but before their first birth day, giving un-weighted post neonatal mortality rate of 15/1000 live births. So, the overall un-weighted infant mortality (neonatal plus post neonatal) was 32/1000 live births. Besides, 167 of the children died after their first birth date but before their fifth birth date, giving un-weighted child mortality rate of 8/1000 live births (figure 5) or 10/1000 children of age 1-4 years.

It is evident from figure 5, that about 79% and 44% of all under-five mortalities occurred before their first birth date and within the first one month of age, respectively. About 82% of neonatal deaths occurred within the first seven days of life (figure 5).

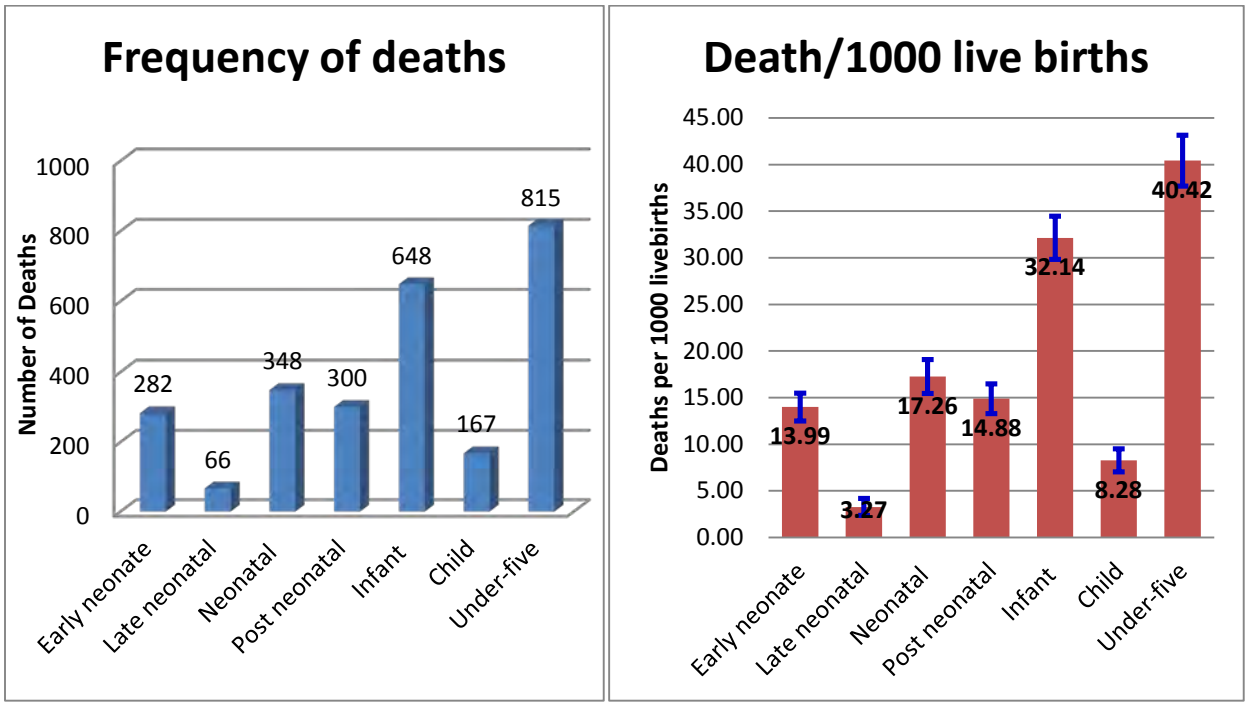

Figure 5: Number of deaths and mortality rates with corresponding error bars by age category, for 7 year periods prior to the survey, Gamo Gofa Zone, 2014

As displayed in table 4, over all under-five mortality was significantly low in DSS kebeles (32/1000 live births) and urban kebeles (34/1000 live births) compared to non-DSS rural kebeles (52/1000 live births) of Arba Minch District. Infant and neonatal mortalities were also significantly high in non-DSS kebeles of Arba Minch Zuria District than DSS and urban kebeles (Table 4).

4.1.2.2. Description of Weighted mortalities

In order to account for the non-proportional allocation of the kebeles/study subjects among urban and rural, a weighted analysis was performed as explained at the method above. As indicated in table 4 below, the overall weighted under-five mortality with its 95% confidence interval was 42.75(39.55-45.96) per 1000 live births. The corresponding weighted mortalities per 1000 live births with their corresponding 95% confidence intervals were 8.87(7.38-10.35) for child, 33.88(31.02-36.75) for infant, 15.21(13.28-17.15) for post neonatal, 18.67(16.52-20.81) for neonatal, 3.44(2.51-4.37) for late neonatal and 15.23(13.28-17.17) for early neonatal (table 4). Besides, child mortality per 1000 children of age 1-4 years was 10.82(9.15 -12.78).

Significant difference of mortality was observed among rural and urban children. Under-five mortality was found to be significantly higher among rural kebeles (death/1000 live birth and 95% confidence interval (CI) of 43.08 (39.76-46.39)) than urban kebeles (death/1000 live birth and 95% CI of 33.77 (29.10-38.44)). Neonatal mortality was also high in rural kebeles (death/1000 live birth and 95% CI of 18.87 (16.65-21.09)) than urban kebeles (death/1000 live birth and 95% CI of 13.23 (10.27-16.18)) (table 4).

There was significant difference of mortality among males and females. Under-five mortality was significantly high among males (death/1000 live birth and 95% CI of 49.08(44.54-54.06) than females (death/1000 live birth and 95% CI of 35.92(31.92-40.41). Similarly, significantly high infant and neonatal mortality rates were observed among males than females (table 4).

Table 4: Mortality rates by: urban-rural, 3 categories of kebeles and sex of the child, for seven-year periods prior to the survey, Gamo Gofa Zone, 2014

Age category	By the three categories of kebeles (Un-weighted data)	Mortality/1000 Live births	(95% Conf. Interval)		P-value
Under-five	Non-DSS Rural	52.24	47.30	57.18	1
	Urban	33.77	29.10	38.44	<0.001
	DSS	32.30	28.04	36.56	<0.001
Neonatal	Non-DSS Rural	25.54	22.04	29.05	1
	Urban	13.23	10.27	16.18	<0.001
	DSS	11.02	8.50	13.53	<0.001
Infant	Non-DSS Rural	41.20	36.79	45.62	1
	Urban	27.15	22.95	31.36	<0.001
	DSS	25.81	21.99	29.63	<0.001
Child	Non-DSS Rural	11.04	8.72	13.36	1
	Urban	6.61	4.52	8.71	<0.001
	DSS	6.49	4.56	8.42	<0.001
Age category	**By rural-urban (Weighted data)**	**Mortality/1000 Live births**	**(95% Conf. Interval)**		**P-value**
Under-five	Over all	42.75	39.55	45.96	
	Rural	43.08	39.76	46.39	1
	Urban	33.77	29.10	38.44	0.003
Early Neonatal	Over all	15.23	13.28	17.17	
	Rural	15.40	13.39	17.41	1
	Urban	10.44	7.82	13.07	0.007
Late neonatal	Over all	3.44	2.51	4.37	
	Rural	3.47	2.51	4.43	1
	Urban	2.79	1.42	4.15	0.444
Neonatal	Over all	18.67	16.52	20.81	
	Rural	18.87	16.65	21.09	1
	Urban	13.23	10.27	16.18	0.006
Post neonatal	Over all	15.21	13.28	17.15	
	Rural	15.26	13.26	17.26	1
	Urban	13.93	10.90	16.96	0.480
Infant	Over all	33.88	31.02	36.75	
	Rural	34.13	31.17	37.09	1
	Urban	27.15	22.95	31.36	0.011
Child	Over all	8.87	7.38	10.35	
	Rural	8.95	7.41	10.49	1
	Urban	6.61	4.52	8.71	0.100
Age category	**By Sex of the children (Weighted data)**	**Mortality/1000 Live births**	**(95% Conf. Interval)**		**P-value**
Under-five	Male	49.08	44.54	54.06	1
	Female	35.92	31.92	40.41	<0.001
Infant	Male	39.50	35.43	44.01	1
	Female	27.83	24.32	31.83	<0.001
Neonatal	Male	24.15	20.99	27.78	1
	Female	12.76	10.44	15.59	<0.001

4.1.2.3. Trends of mortality

In order to have full year mortality data to assess trends in child mortality, the data were reorganized in to the Ethiopian calendar years (the calendar year starts in September). As displayed in figure 6, the result didn't show a significant change in under-five mortality throughout the study time (X^2=0.75, p-value=0.39) in overall study kebeles. However, unlike other kebeles, under-five mortality in DSS kebeles was found to be significantly decreasing (X^2=10.16, P=0.001). More or less similar trends were observed in infant and neonatal mortalities, i.e. fluctuating trends in the overall and non-DSS rural and urban kebeles, but sharp reduction in DSS kebeles (Figure 6).

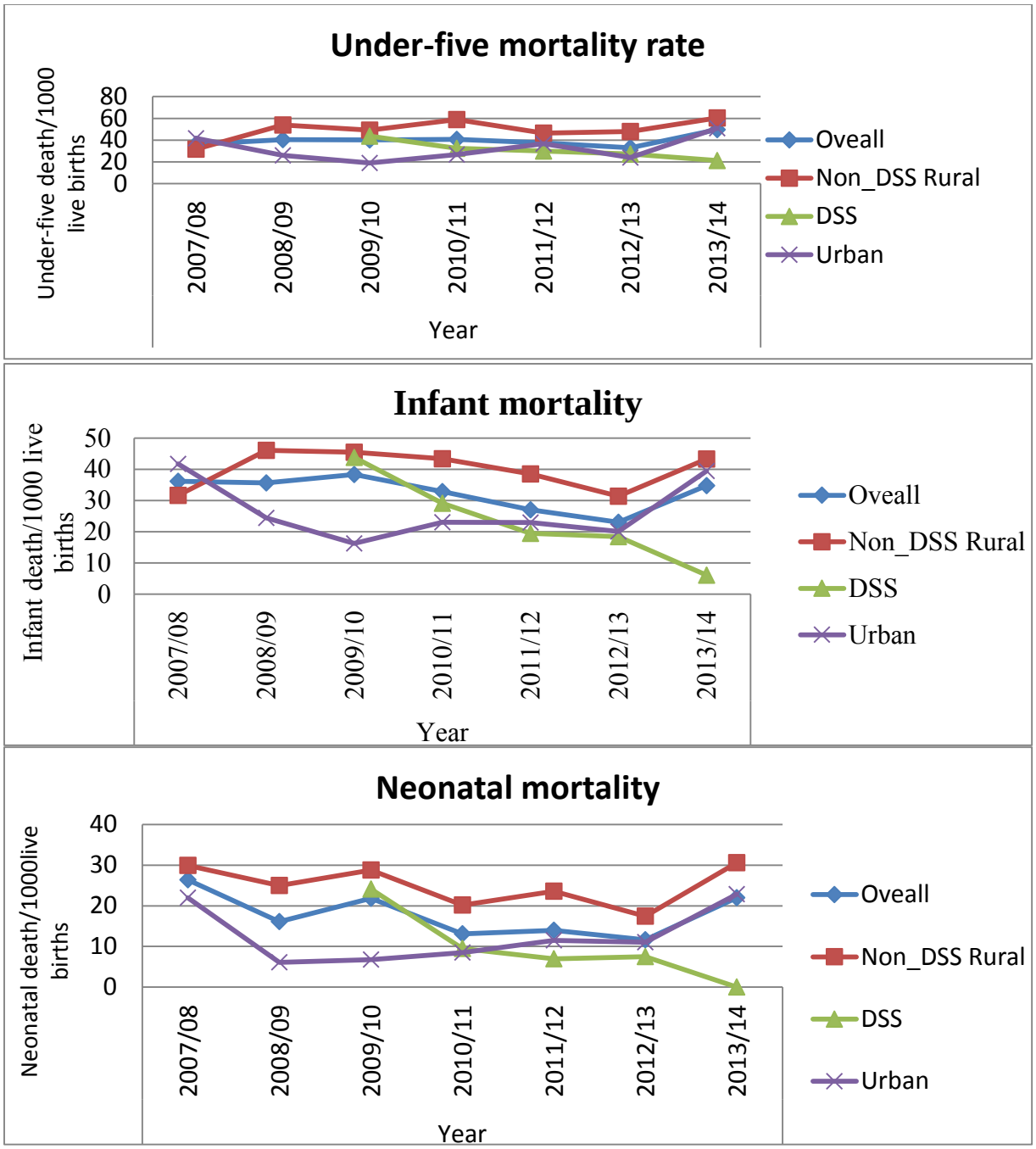

Figure 6: Trends of mortalities by different categories of the kebeles, Gamo Gofa Zone, September 2007-September 2014

4.2. Determinants of under-five mortality

4.2.1. Socioeconomic-demographic characteristics of the respondents

All the 383 cases identified from the census and Arba Minch DSS and their corresponding 766 controls were approached for this study, but data from 381 cases and 762 controls were obtained from 11 urban and 20 rural kebeles. Data from two cases and their corresponding four controls were not retrieved from two kebeles since the respective cases migrated from their initial location.

As displayed in table 5 below, 210(55.1%) of cases and 382(50.1%) of controls were males. Majority of mothers of cases 332(87.1%) and controls 688(90.3%) were age between 18 and 35 years. Most of mothers of the cases 251(65.9%) and the controls 517(67.8%) were protestant. With regard to the maternal education, more than half 218(57.2%) of cases and less than half 360(47.2%) of controls had no formal education. Ethnically, majority of mothers of the cases 286(75.1%) and the controls 571(74.9%) were Gamo.

Most of mothers of the cases 264(69.3%) and controls 539(70.7%) were housewives. Majority of mothers of the cases 358(94.0%) and the controls 731(95.9%) were married. Sixty three (16.5%) and 76(10.0%) of mothers of the cases and the controls, respectively, were married to a polygamous husband. Nearly half of the husbands of the cases 190(49.9%) and the controls 433(56.8%) were farmers. With regard to maternal decision power, 202(53.0%) of the cases and 437(57.3%) of controls had god decision power. Only 124(32.5%) of the cases were classified as rich, whereas, 328(43.0%) of the controls were classified as rich (table 5).

Table 5: Socioeconomic-demographic characteristics of the children/their mothers for determinants of mortality, Gamo Gofa Zone, 2014

Characteristics		Survival status of the child		Total
		Dead	Alive	
Sex of the child	Male	210(55.1%)	382(50.1%)	592(51.8%)
	Female	171(44.9%)	380(49.9%)	551(48.2%)
Age category of the child	Early neonate	100(26.3%)	200(26.3%)	300(26.3%)
	Neonate	125(32.8%)	250(32.8%)	375(32.8%)
	Infant	263(69.0%)	526(69.0%)	789(69.0%)
	Under-five	381(100%)	762(100%)	1143(100%)
Maternal age at birth of the child	<18year	7(1.8%)	12(1.6%)	19(1.7%)
	18-35year	332(87.1%)	688(90.3%)	1020(89.2%)
	>35year	42(11.0%)	62(8.1%)	104(9.1%)
Mother Religion	Protestant	251(65.9%)	517(67.8%)	768(67.2%)
	Orthodox	115(30.2%)	216(28.3%)	331(29.0%)
	Others	15(3.9%)	29(3.8%)	44(3.8%)
Mother education	No formal education	218(57.2)	360(47.2)	578(50.6)
	Grade1-6	104(27.3)	189(24.8)	293(25.6)
	Grade7-8	24(6.3)	79(10.4)	103(9.0)
	Grade9 and above	35(9.2)	134(17.6)	169(14.8)
Mother ethnicity	Gamo	286(75.1%)	571(74.9%)	857(75.0%)
	Gofa	8(2.1%)	20(2.6%)	28(2.4%)
	Wolayta	26(6.8%)	52(6.8%)	78(6.8%)
	Zeyse	37(9.7%)	78(10.2%)	115(10.1%)
	Amhara	6(1.6%)	19(2.5%)	25(2.2%)
	Others	18(4.7%)	22(2.9%)	40(3.5%)
Mother Occupation	Farmer	22(5.8%)	35(4.6%)	57(5.0%)
	House wife	264(69.3%)	539(70.7%)	803(70.3%)
	Gov't employee	14(3.7%)	36(4.7%)	50(4.4%)
	Merchant	36(9.4%)	84(11.0%)	120(10.5%)
	Others	45(11.8%)	68(8.9%)	113(9.9%)
Marital status	Married	358(94.0%)	731(95.9%)	1089(95.3%)
	Single	11(2.9%)	21(2.8%)	32(2.8%)
	Others	12(3.1%)	10(1.3%)	22(1.9%)
How many wife the husband had	Mother only	318(83.5%)	686(90.0%)	1004(87.8%)
	More than one wife	63(16.5%)	76(10.0%)	139(12.2%)
Husband occupation	Farmer	190(49.9%)	433(56.8%)	623(54.5%)
	Gov't or NGO employee	34(8.9%)	96(12.6%)	130(11.4%)
	Merchant or self-employee	33(8.7%)	73(9.6%)	106(9.3%)
	Daily laborer	66(17.3%)	61(8.0%)	127(11.1%)
	Student	6(1.6%)	15(2.0%)	21(1.8%)
	Others	29(7.6%)	53(7.0%)	82(7.2%)

	No husband	23(6.0%)	31(4.1%)	54(4.7%)
Maternal power	Poor	160 (42.0)	290(38.1)	450(39.4)
	Average	19(5.0)	35(4.6)	54(4.7)
	Good	202(53.0)	437(57.3)	639(55.9)
Wealth index of the family	Poor	159(41.7%)	298(39.1%)	457(40.0%)
	Average	98(25.7%)	136(17.8%)	234(20.5%)
	Rich	124(32.5%)	328(43.0%)	452(39.5%)

4.2.2. Determinants of under-five mortality

As outlined in the method's chapter, to examine determinant factors of childhood mortality, consecutive models were developed at different levels of the predicting factors for each age category (infant and under-five children) based on the conceptual framework. The first model (model 1) was developed for distal factors. Then, a separate model for each category of proximal factors was developed by controlling distal factors which were significant at p-value of 0.10 and selected factors in that specific category.

4.2.2.1. Association of socioeconomic-demographic characteristics (distal factors) with under-five mortality

As it is depicted in table 6 (model 1), the adjusted weighted conditional logistic regression revealed that, among distal factors, maternal education, marital status of the mother and husband occupation were factors significantly associated with under-five and/or infant mortality.

The odds of death among under-five children of mothers whose educational status were grade nine or above was 66% (adjusted odds ratio (AOR) of 0.34(0.16-0.72)) less than among children of mothers who lacked formal education. Similarly, educational status of the mother was shown to be inversely associated with infant mortality (AOR of 0.37(0.15-0.91)) (table 6).

The odds of death among under-five children whose mothers' marital status were in other category (separated/divorced or widowed) were about four times (AOR of 3.60(1.23-10.47)) higher than among whose mothers were married. Similarly, infants whose mothers' marital status were in other category (separated/divorced or widowed) had about seven times (AOR of 6.68(1.81-24.71)) higher rate of odds of death than whose mothers were married (table 6).

Under-five children whose fathers were daily laborers had more than two times (AOR of 2.34(1.29-4.23)) higher rate of odds of death than those whose fathers were farmers. Though it is not significant, infants whose fathers were daily laborers had about 1.8 times (AOR of 1.79(0.86-3.74)) higher rate of odds of death than those whose fathers were farmers (table 6).

Though the association between wealth index of the household and under-five mortality was in the expected direction (children of poor families had a higher rate of odds of death), it was not statistically significant with AOR of 1.49(0.85-2.62) for average and AOR of 1.52(0.93-2.48) for poor when compared with rich categories. Index of maternal power in the household was not significantly associated with under-five mortality with AOR of 1.48(0.69-3.19) for average and AOR of 0.91(0.65-1.28) for good when compared to the poor categories. Other distal factors which were not statistically significantly associated with under-five and infant mortality were family size, mother's occupation, religion and ethnicity of the mother (table 6).

Table 6: Association of socioeconomic-demographic characteristics (distal factors) with child mortality, Gamo Gofa Zone, 2014

Characteristics	Categories	Under-five*			Infants*		
		AOR	(95% Conf. Interval)		AOR	(95% Conf. Interval)	
Sex of the child	Male	Ref					
	Female	0.76	0.57	1.02	0.75	0.52	1.08
Mother's religion	Protestant	Ref					
	Orthodox	1.27	0.86	1.87	1.10	0.67	1.79
	Others	1.19	0.53	2.67	1.40	0.41	4.71
Mother's Ethnicity	Gamo	Ref					
	Zeyse	1.09	0.38	3.17	0.62	0.14	2.82
	Wolayta	1.08	0.48	2.40	0.66	0.25	1.76
	Others	1.66	0.87	3.18	1.37	0.63	2.98
Mother's education	No formal education	Ref					
	Grade1-6	0.95	0.63	1.43	0.97	0.57	1.65
	Grade7-8	0.67	0.35	1.31	0.69	0.31	1.56
	Grade 9 and above	**0.34**	**0.16**	**0.72**	**0.37**	**0.15**	**0.91**
Mother's Occupation	Farmer	Ref					
	House Wife	0.70	0.32	1.52	0.59	0.25	1.38
	Gov't employee	0.57	0.12	2.76	0.80	0.14	4.61
	Merchant	0.50	0.20	1.28	0.43	0.15	1.28
	Others	1.31	0.44	3.90	1.10	0.33	3.66
Marital status	Married	Ref					
	Single	1.22	0.42	3.54	0.49	0.11	2.30
	Others	**3.60**	**1.23**	**10.47**	**6.68**	**1.81**	**24.71**
Husband occupation	Farmer	Ref					
	Gov't employee	0.70	0.31	1.55	0.78	0.30	2.03
	Merchant	1.84	0.92	3.66	1.43	0.66	3.08
	Daily laborer	**2.34**	**1.29**	**4.23**	1.79	0.86	3.74
	Student	1.27	0.42	3.87	1.47	0.32	6.77
	Others	1.67	0.86	3.24	1.54	0.69	3.44
Wealth index of Household	Rich	Ref					
	Average	1.49	0.85	2.62	1.51	0.74	3.07
	Poor	1.52	0.93	2.48	1.75	0.97	3.16
Number of individuals living in the house		0.94	0.87	1.03	0.93	0.83	1.03
Maternal power	Poor	Ref					
	Average	1.48	0.69	3.19	1.88	0.80	4.44
	Good	0.91	0.65	1.28	0.89	0.57	1.38

**Adjusted for all variables in the table*

4.2.2.2. Proximate factors

As mentioned above, separate four models for each category of proximate factors were fitted: 1) environmental contamination factors, 2) maternal and child factors, 3) child feeding and newborn care practices related and 4) personal illness control related factors.

4.2.2.2.1. Environmental contamination factors

Among factors classified as environmental contamination; presence of separate kitchen was significantly associated with both under-five and infant mortality. The odds of death among under-five children from a household with no separate kitchen for cooking was about 1.8 times (AOR of 1.77(1.16-2.70)) higher than among those with kitchen. Similarly, infants from households with no separate kitchen had about 1.9 times (AOR of 1.94(1.13-3.33)) higher rate of odds of death than those with kitchen. The odds of death among infants whose household's source of light was electricity was less (with AOR of 0.47(0.23-0.99)) than among those whose source was other than electricity (table 7).

Surprisingly, presence or type of latrine was not significantly associated with under-five mortality with AOR of 1.03(0.60-1.76) for pit latrine and AOR of 1.37(0.50-3.73) for ventilated and improved pit (VIP)/ flush toilet when compared to no latrine. Similarly, source of water was not significantly associated with under-five mortality with AOR of 0.92(0.51-1.66) for protected well/spring and AOR of 1.02(0.61-1.72) for unprotected well/spring/river/pond when compared with tap water. Environmental contamination related factors like presence of window and sharing the house with animals were also not significantly associated with under-five and infant mortality (table 7). However, in sub-group analysis, under-five children from households without latrine had a higher rate of odds of mortality than children from households with latrine in urban kebeles, albeit the small sample size resulted in a wide confidence interval (AOR=22.34(1.48-337.63).

Table 7: Association between environmental contamination factors & under-five mortality, Gamo Gofa Zone, 2014

Characteristics	Under-five*			Infants**		
	AOR	(95% Conf. Interval)		AOR	(95% Conf. Interval)	
The house has window						
Yes	RF					
No	0.74	0.45	1.23	0.75	0.40	1.40
Did animals live with people						
Yes	Ref					
No	1.17	0.72	1.92	1.07	0.60	1.90
Had kitchen						
Yes	Ref					
No	**1.77**	**1.16**	**2.70**	**1.94**	**1.13**	**3.33**
Type of latrine the family had						
No latrine	Ref					
Pit latrine	1.03	0.60	1.76	1.04	0.51	2.11
VIP/Flush	1.37	0.50	3.73	1.04	0.30	3.65
Main source of water						
Tap	Ref					
Protected well/spring	0.92	0.51	1.66	1.48	0.69	3.20
Unprotected well/spring/river/pond	1.02	0.61	1.72	1.26	0.63	2.52
Source of light of the household						
Other than electricity	Ref					
Electricity	0.87	0.48	1.57	**0.47**	**0.22**	**0.99**

**Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index, husband occupation and marital status of the mother*
*** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index and marital status of the mother*

4.2.2.2.2. Maternal and child factors

Among maternal and child related factors included in model 3 (table 8); birth interval, history of child death before the index child, type of birth of index child and presence of live birth after index child were significantly associated with under-five and/or infant mortality. Under-five children who had birth interval of 24-36months (AOR of 0.48(0.28-0.82)) or more than 36 months (AOR of 0.46(0.26-0.79)) had less odds of mortality than those children who had birth interval of less than 24months. Similarly, infants who had birth interval of 24-36months (AOR of 0.28 (0.14-0.54)) or more than 36 months (AOR of 0.29 (0.15-0.55)) had less odds of mortality than infants who had birth interval of less than 24months (table 8). Under-five children (AOR of 1.97(1.07-3.61)) and infants (AOR of 3.37 (1.51-7.50)) with history of death of older siblings had a higher rate of odds of mortality than those without history of death of older siblings (table 8).

Those under-five children whose births were multiple had higher rate of odds of mortality (AOR of 13.72(5.26-35.79)) than those who were single birth. Similar effect was observed among infants (AOR of 21.18 (5.85-76.74)). Under-five children of mothers with history of birth after the index child had a higher rate of mortality (AOR of 5.06(2.80-9.16)) than those without. However, age of mothers at child birth, gravidity and birth order of index child were not significantly associated with under-five mortality in this study (table 8).

Table 8: Association between maternal and child factors with under-five mortality Gamo Gofa Zone, 2014

Characteristics	Under-five*			Infants**		
	AOR	(95% Conf. Interval)		AOR	(95% Conf. Interval)	
Age of mother at child birth	1.03	0.97	1.09	1.06	1.00	1.13
Number of pregnancies before index child	1.04	0.87	1.25	0.91	0.72	1.15
Birth order of index child						
first	Ref					
second	0.71	0.13	3.76	5.29	0.47	59.54
Third	1.06	0.20	5.32	3.73	0.40	34.88
fourth	0.71	0.14	3.19	4.35	0.47	40.03
Birth Interval						
<24months	Ref					
24-36months	**0.48**	**0.28**	**0.82**	**0.28**	**0.14**	**0.54**
>36months	**0.46**	**0.26**	**0.79**	**0.29**	**0.15**	**0.55**
first birth	1.01	0.16	6.45	0.64	0.07	5.67
History of child death before index child						
No	Ref					
Yes	**1.97**	**1.07**	**3.61**	**3.37**	**1.51**	**7.50**
Type of birth						
Single birth	Ref					
Multiple birth	**13.72**	**5.26**	**35.79**	**21.18**	**5.85**	**76.74**
History of child birth after index child						
No	Ref					
Yes	**5.06**	**2.80**	**9.16**			

** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index, husband occupation and marital status of the mother*
*** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index and marital status of the mother*

4.2.2.2.3. Child feeding and newborn care practices

Among factors related with child feeding and newborn care practices: history of ever breast feeding and timing of first bath of the index child were significantly associated with under-five mortality. Under-five children who were never breast fed had about eight times (AOR of 8.09(4.08-16.05)) higher rate of odds of mortality than those ever breast fed. Similarly, those infants who were never breast fed had higher rate of odds of mortality (AOR of 14.19(5.51-36.50)) than those who were ever breast fed. Delaying first bath of a child at least to 24 hours after birth was shown to reduce odds of under-five mortality by 50% (AOR of 0.50(0.34-0.73)) and odds of infant mortality by 54% (AOR of 0.46(0.28-0.77)) than having first bath within 24 hours of birth (table 9).

Although the associations were in expected direction, the association between under-five and/or infant mortality and factors like exclusive breast feeding status of the child, history of bottle feeding, breastfeeding initiation time and history of something applied to the umbilical wound were not significant, (table 9). However, in sub-group analysis under-five children who initiated breastfeeding after one hour of birth had about 3.7 times higher odds of mortality (AOR=3.67 (1.17-11.50) than those who initiated within one hour of birth in urban kebeles. Similarly, under-five children who were partially breastfed had a higher odds of mortality (AOR=2.52(1.10-5.77) than those who were exclusively breastfed in urban kebeles.

Table 9: Association between child feeding and newborn care practices and under-five mortality, Gamo Gofa Zone, 2014

Characteristics	Under-five*			Infants**		
	AOR	(95% Conf. Interval)		AOR	(95% Conf. Interval)	
Ever Breast fed						
Yes	RF					
No	**8.09**	**4.08**	**16.05**	**14.19**	**5.51**	**36.50**
First breast feeding started						
Within 1hr	Ref					
After 1hr	1.55	0.95	2.51	1.43	0.80	2.59
Breast feeding status within 6month of age						
Exclusive	Ref					
Predominantly	0.94	0.38	2.29	1.19	0.41	3.45
Partially	1.29	0.86	1.94	0.91	0.54	1.51
Bottle feeding						
Yes	Ref					
No	0.89	0.49	1.64	1.41	0.57	3.50
Timing of first bath						
Within 24 hour of birth	Ref					
After 24 hour of birth	**0.50**	**0.34**	**0.73**	**0.46**	**0.28**	**0.77**
Anything applied to umbilical wound						
Yes	Ref					
No	0.91	0.63	1.32	0.88	0.53	1.44

** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index, husband occupation and marital status of the mother*
*** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index and marital status of the mother*

4.2.2.2.4. Personal illness control related factors

Among factors classified as personal illness control; post natal care (PNC) for the index pregnancy/child, antenatal care (ANC) for the index pregnancy, immunization status of the child for his /her age and whether the child had vitamin A or not were significantly associated with under-five and/or infant mortality (Table 10).

The odds of mortality was more than two times higher among under-five children who lacked PNC (AOR of 2.27(1.25-4.11)) than those who had. Similarly, lack of PNC service was shown to increase the odds of mortality by more than two folds during the first year of life of the child (AOR of 2.35(1.02-5.45)). Infants who had at least four ANC follow-up during their pregnancy had less odds of mortality (AOR of 0.45(0.23-0.90)) than those infants who lacked ANC. Though it is not statistically significant, similar effect was observed among under-five children with AOR of 0.72(0.42-1.24) (Table 10).

The odds of mortality among under-five children who were partially immunized for their age, was about four times (AOR of 3.62(2.02-6.50)) higher than those fully immunized. The odds of mortality among under-five children, who were not immunized at all, was about 11 times (AOR of 11.02(5.16-23.53)) higher than children who were fully immunized for their age. Similarly, significant increment of odds of mortality was observed among partially (AOR of 4.10(1.81-9.30)) and not immunized (AOR of 18.54(6.22-55.26)) infants than fully immunized infants (Table 10).

Under-five children who didn't take vitamin A at least once after six months of their age had about eight times (AOR of 7.61(4.72-12.26)) higher odds of mortality than those who did. Similarly, lack of vitamin A was shown to increase odds of mortality during the first year of age of the child (AOR of 15.29(6.38-36.65)). Unexpectedly, place or attendants of delivery of index child were not significantly associated with under-five mortality in this study (Table 10).

Table 10: Association between personal illness control related factors and under-five mortality, Gamo Gofa Zone, 2014

Characteristics	Under-five*			Infants**		
	AOR	(95% Conf. Interval)		AOR	(95% Conf. Interval)	
Had post-natal care for the index child						
Yes	Ref			Ref		
No	**2.27**	**1.25**	**4.11**	**2.35**	**1.02**	**5.45**
Number of ANC follow up for index pregnancy						
No ANC follow up	Ref			Ref		
Less than 4	0.88	0.51	1.54	0.58	0.27	1.24
Greater than or equal to 4	0.72	0.42	1.24	**0.45**	**0.23**	**0.90**
Place of delivery						
Home	Ref			Ref		
Hospital	1.43	0.32	6.45	1.76	0.27	11.53
Health center	0.96	0.20	4.62	0.95	0.13	7.00
Health post	1.72	0.72	4.15	2.24	0.66	7.56
Others	0.58	0.09	3.86	0.62	0.08	4.87
Attendant of delivery						
Skilled health professionals	Ref			Ref		
Health extension worker	0.64	0.14	2.88	0.37	0.05	2.74
Traditional birth attendants (TBA)	0.36	0.07	1.90	0.47	0.05	4.05
Relative/Neighbor/Mother Herself	0.61	0.14	2.81	0.46	0.07	3.17
Immunization status of the child						
Fully immunized for age	Ref			Ref		
Partially immunized for age	**3.62**	**2.02**	**6.50**	**4.10**	**1.81**	**9.30**
Not immunized	**11.02**	**5.16**	**23.53**	**18.54**	**6.22**	**55.26**
Did the child have vit. A (for those >=6Month old)						
Yes	Ref			Ref		
No	**7.61**	**4.72**	**12.26**	**15.29**	**6.38**	**36.65**

** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index, husband occupation and marital status of the mother*
*** Besides the variables in the table, adjusted for sex of the child and significant distal factors such as mother's education, wealth index, husband occupation and marital status of the mother*

4.3. Effect of child death on maternal mental distress

4.3.1. Socioeconomic-demographic characteristics of the mothers

Data from a total of 1068 mothers (356 exposed and 712 controls) were retrieved giving a response rate of 98.3%. The overall mean (SD) age of the mothers was 27.06(6.18) years. The mean (SD) age of exposed mothers was 27.04 (6.42) years. For that of unexposed mothers the mean (SD) age was 27.07 (6.06) years. Majority of exposed (87.4%) and unexposed (89.9%) mothers were in the age group of 18-35 years. Majority of exposed (75.0%) and unexposed (74.3%) mothers were from Gamo Ethnic Group. Most of the exposed (67.4%) and unexposed (68.5%) mothers were protestant. More than half (56.2%) of exposed mothers lacked formal education, whereas, less than half (46.9%) of unexposed mothers had no formal education (table 11).

Majority of exposed (68.0%) and unexposed (70.6%) mothers were housewives. Majority of exposed (91.6%) and unexposed (94.1%) mothers were married at the time of the survey. Fifty nine (18.1%) of exposed mothers' husband were daily laborers whereas, only 7.9% of unexposed mothers' husband were daily laborers. Two hundred eight (63.8%) of exposed and 68.9% of unexposed mothers' husbands had at least primary level education. With regard to wealth index, 42.1% of exposed and 39% of unexposed mothers were from poor households. One hundred twenty four (34.8%) of exposed and 29.6% unexposed mothers had poor decision making status in the household (table 11).

Table 11: Socioeconomic-demographic characteristics of the mothers for mental distress assessment, Gamo Gofa Zone, 2014

Characteristics	Categories	Exposed	Unexposed	Total
		N (%)	N (%)	N (%)
Age category of the mother	<18yr	7(2.0)	11(1.5)	18(1.7)
	18-35yr	311(87.4)	640(89.9)	951(89.0)
	>35	38(10.7)	61(8.6)	99(9.3)
Ethnicity	Gamo	267(75.0)	529(74.3)	796(74.5)
	Gofa	7(2.0)	19(2.7)	26(2.4)
	Wolayta	25(7.0)	47(6.6)	72(6.7)
	Zeyse	37(10.4)	78(11.0)	115(10.8)
	Amhara	5(1.4)	19(2.7)	24(2.2)
	others	15(4.2)	20(2.8)	35(3.3)
Religion	Protestant	240(67.4)	488(68.5)	728(68.2)
	Orthodox	101(28.4)	196(27.5)	297(27.8)
	Others	15(4.3)	28(3.9)	43(4.1)
Educational level	No formal education	200(56.2)	334(46.9)	534(50.0)
	Grade1-6	100(28.1)	174(24.4)	274(25.7)
	Grade7-8	22(6.2)	71(10.0)	93(8.7)
	Grade9-12	18(5.1)	85(11.9)	103(9.6)
	Above grade12	16(4.5)	48(6.7)	64(6.0)
Occupation	Farmer	18(5.1)	35(4.9)	53(5.0)
	House wife	242(68.0)	503(70.6)	745(69.8)
	Gov't employee	19(5.3)	48(6.7)	67(6.3)
	Merchant	41(11.5)	81(11.4)	122(11.4)
	Daily laborer	21(5.9)	11(1.5)	32(3.0)
	Housemaid	3(0.8)	4(0.6)	7(0.7)
	Student	9(2.5)	22(3.1)	31(2.9)
	Other	3(0.8)	8(1.1)	11(1.0)
Marital status	Married	326(91.6)	670(94.1)	996(93.3)
	Single	7(2.0)	20(2.8)	27(2.5)
	Divorced	6(1.7)	5(0.7)	11(1.0)
	Widowed	9(2.5)	4(0.6)	13(1.2)
	Separated	8(2.2)	13(1.8)	21(2.0)
Husband occupation	Farmer	177(54.3)	401(59.9)	578(58.0)
	Gov't employee	32(9.8)	91(13.6)	123(12.3)
	Merchant	25(7.7)	64(9.6)	89(8.9)
	Student	5(1.5)	10(1.5)	15(1.5)
	Daily laborer	59(18.1)	53(7.9)	112(11.2)
	Other	28(8.6)	51(7.6)	79(7.9)
Husband education	No formal education	118(36.2)	208(31.1)	326(32.7)
	Grade 1-6	108(33.1)	187(27.9)	295(29.6)
	Grade 7-8	34(10.4)	78(11.6)	112(11.2)
	Grade 9-12	34(10.4)	113(16.9)	147(14.8)
	>Grade 12	32(9.8)	84(12.5)	116(11.6)
Wealth index	Poor	150(42.1)	278(39.0)	428(40.1)
	Average	90(25.3)	127(17.8)	217(20.3)
	Rich	116(32.6)	307(43.1)	423(39.6)
Maternal Power	Poor	124(34.8)	211(29.6)	335(31.4)
	Average	125(35.1)	260(36.5)	385(36.0)
	Good	107(30.1)	241(33.8)	348(32.6)

4.3.2. Mental distress among the mothers

The internal reliability of the SRQ-20 was excellent with Cronbach's alpha of 0.902. As depicted in table 12, the most commonly reported symptoms include: "headache" (52.8%), "easily tire" (43.2%), "feel tired all the time" (40.2%) and "feel nervous, tense or worried" (38.2%). Overall 18.6% of the mothers reported that they had suicidal ideation within the last 30 days before the survey. Significantly, higher rate of suicidal ideation was reported by exposed mothers (23.3%) than unexposed ones (16.3%), p-value of 0.003.

The overall mean (SD) SRQ score value was 5.7 ± 5.1 ranging between 0 and 20. Whereas, the mean scores of exposed and unexposed mothers were 6.4 ± 5.3 and 5.4 ±5.1, respectively. Based on a cutoff point of six or above "yes" to the SRQ questions, overall, 446 (41.8%) of the participants were positive for mental distress. One hundred seventy one (48%) of exposed mothers were positive for mental distress, whereas only 275(38.6%) of unexposed mothers were positive for mental distress (Table 12). When non-proportional allocation of the participants to urban and rural communities was accounted for (through weighting), 49.1% of exposed and 40.7% of unexposed mothers were positive for mental distress with overall prevalence of 43.5%.

As shown on figure 7, the magnitude of maternal mental distress among mothers with child death was shown to be decreasing as time went. The magnitude of mental distress was 55.7% among mothers who experienced child loss in the past six months. It decreased to 43% among mothers who experienced child loss more than three years before the survey. Mental distress was found to be persistently high among mothers with history of child loss compared to mothers without child loss at least for three to four years after child death (X^2=10.65, P= 0.001). The effect is greater during the earlier periods (within 6 months of child death) (Figure 7).

Table 12: Proportion of exposed and unexposed mothers who said yes to SRQ-20 questions, Gamo Gofa Zone, 2014

S. No.	SRQ 20-Questions	Exposed (who said yes)	Unexposed (who said yes)	Total (who said yes)
		Freq. (%)	Freq. (%)	Freq. (%)
1.	Often had headache	201(56.5)	363(51.0)	564(52.8)
2.	Had poor appetite	132(37.1)	273(38.3)	405(37.9)
3.	Problem with sleep	90(25.3)	164(23.0)	254(23.8)
4.	Easily frightened	86(24.2)	161(22.6)	247(23.1)
5.	Hands shake	39(11.0)	66(9.3)	105(9.8)
6.	Feel nervous, tense or worried	159(44.7)	249(35.0)	408(38.2)
7.	Poor digestion	92(25.8)	153(21.5)	245(22.9)
8.	Trouble thinking clearly	108(30.3)	185(26.0)	293(27.4)
9.	Feel unhappy?	121(34.0)	189(26.5)	310(29.0)
10.	Cry more than usual	81(22.8)	114(16.0)	195(18.3)
11.	Difficulty to enjoy daily activities	106(29.8)	165(23.2)	271(25.4)
12.	Difficulty to make decisions	92(25.8)	147(20.6)	239(22.4)
13.	Daily work suffering	106(29.8)	174(24.4)	280(26.2)
14.	Unable to play a useful part in life	114(32.0)	188(26.4)	302(28.3)
15.	Lost interest in things	115(32.3)	175(24.6)	290(27.2)
16.	Feeling of worthlessness	111(31.2)	155(21.8)	266(24.9)
17.	Thought of ending life	83(23.3)	116(16.3)	199(18.6)
18.	Feel tired all the time	162(45.5)	267(37.5)	429(40.2)
19.	Uncomfortable feelings in stomach	116(32.6)	212(29.8)	328(30.7)
20.	Easily tired	164(46.1)	297(41.7)	461(43.2)
Positives for mental distress (95% CI)		**48.0(42.9-53.2)**	**38.6 (35.1-42.3)**	**41.8 (39-45)**

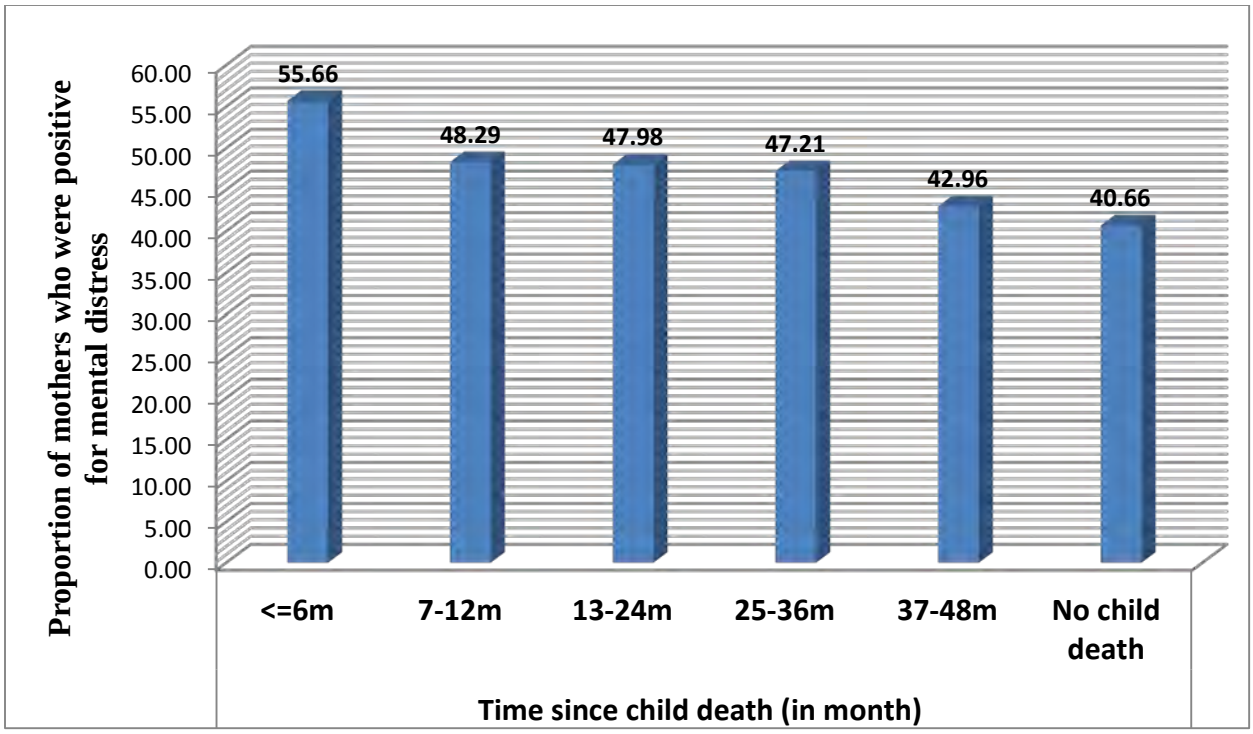

Figure 7: The weighted proportion of mothers who had mental distress, by time since child death, Gamo Gofa Zone, 2014

4.3.3. Effect of child death on maternal mental distress

In bivariate analysis, history of child loss was significantly associated with mental distress. The odds of mental distress was 1.6 times higher among mothers who lost their children than those who didn't (COR=1.61(1.15-2.25)). After adjusting for potential confounding factors, the odds of mental distress among mothers with child death was more than 1.8 times higher than among those mothers without child death (AOR of 1.84(1.11-3.04) (table 13).

Other variables which were significantly associated with overall mental distress included: wealth index of the household, weather the mother had other medical illnesses or not, whether the family sought medical care from modern health system or not, whether the mother had ANC follow up during the pregnancy of the index child or not and whether the mother has history of adverse pregnancy outcomes (abortion or still birth) or child loss other than the death of the index child (table 13).

Overall, mothers from household of average (AOR of 0.41(0.21-0.79)) and rich (AOR of 0.31(0.14-0.67)) wealth index had less odds of mental distress than those from poor categories. The odds of mental distress among mothers who didn't have other medical problems (including heart problems, hypertension, diabetes mellitus etc.) was 64% (AOR of 0.36(0.18-0.73)) less than among those who reported to have any other medical problems. Similarly, odds of mental distress among mothers who reported seeking medical care from modern health facilities (other than home or traditional healer) was 57% (AOR of 0.43(0.20-0.94)) less than among those mothers who consulted traditional means. Compared to those mothers who reported having ANC follow up during pregnancy of the index child, the odds of mental distress was about 2.6 times (AOR of 2.55(1.25-5.18)) higher among who didn't have ANC follow up (table 13).

In a bivariate analysis, mothers who didn't experience child/pregnancy loss in terms of child death, abortion or stillbirth before or after the index child were less likely to have mental distress (COR of 0.54(0.34-0.87)) than those who ever experienced. When adjusted for survival status of the index child and other variables it lost its significance though the association is in expected direction (table 13). However, when survival status of the index child was removed from the model, the odds of mental distress among mothers who didn't experience child loss in terms of child death, abortion or stillbirth before or after the index child was significantly less (COR of 0.56(0.32-0.99)) than those who ever experienced.

Table 13: Independent effect of child loss and other factors on maternal mental distress, Gamo Gofa, 2014

Characteristics	Categories	COR	(95% CI)		AOR*	(95% CI)	
Exposure status	Un-exposed	**Ref**			Ref		
	Exposed	**1.61**	**1.15**	**2.25**	**1.84**	**1.11**	**3.04**
Age of mother at birth		1.02	0.99	1.06	1.02	0.96	1.08
Ethnicity	Gamo	Ref			Ref		
	Zeyse	0.50	0.10	2.46	0.34	0.03	3.71
	Wolayta	2.22	0.72	6.88	3.28	0.92	11.70
	Others	0.98	0.31	3.95	0.88	0.27	2.87
Maternal education	No formal education	Ref			Ref		
	Grade1-6	1.16	0.67	1.99	**2.00**	**1.01**	**3.97**
	Grade7-8	0.94	0.43	2.06	2.17	0.88	5.36
	Above Grade9	0.70	0.32	1.53	1.86	0.66	5.30
Marital status	Married	Ref			Ref		
	Single	0.85	0.26	2.79	0.50	0.09	2.61
	Other	1.15	0.47	2.81	1.17	0.36	3.82
Mother Occupation	House wife	Ref			Ref		
	Farmer	0.49	0.21	1.15	0.68	0.26	1.73
	Gov't employee	0.37	0.04	3.14	0.56	0.08	3.73
	Merchant	0.97	0.48	1.94	1.00	0.43	2.33
	Others	1.82	0.70	4.70	1.41	0.51	3.89
Wealth index	Poor	Ref			Ref		
	Average	**0.47**	**0.26**	**0.84**	**0.41**	**0.21**	**0.79**
	Rich	**0.39**	**0.20**	**0.77**	**0.31**	**0.14**	**0.67**
Maternal Power	Poor	Ref			Ref		
	Average	0.76	0.46	1.26	0.62	0.32	1.19
	Good	1.19	0.71	2.01	1.45	0.76	2.79
Ever beaten by her husband	Yes	Ref			Ref		
	No	0.98	0.53	1.82	1.08	0.49	2.40
Mother has any medical illness	Yes	Ref			Ref		
	No	**0.42**	**0.23**	**0.76**	**0.36**	**0.18**	**0.73**
Place of seeking health care	Traditional	Ref			Ref		
	Modern health service	**0.43**	**0.22**	**0.85**	**0.43**	**0.20**	**0.94**
Pregnant during survey	Yes	Ref			Ref		
	No	0.75	0.38	1.47	0.65	0.32	1.34
	Unsure	0.80	0.18	3.60	0.41	0.10	1.63
How many child has		1.02	0.93	1.12	1.09	0.93	1.28
Place of delivery	Home	Ref			Ref		
	Health post	0.98	0.36	2.63	0.52	0.17	1.61
	Higher health facility	0.87	0.47	1.60	0.58	0.25	1.37
Had Post natal care during pregnancy of index child	Yes	Ref			Ref		
	No	1.00	0.58	1.73	0.54	0.25	1.18
Had ANC follow up during pregnancy of index child	Yes	Ref			Ref		
	No	**1.81**	**1.01**	**3.24**	**2.55**	**1.25**	**5.18**
Ever had child loss (including abortion & stillbirth) other than index child	Yes	Ref			Ref		
	No	**0.54**	**0.34**	**0.87**	0.60	0.33	1.08
Had live birth after index child	Yes	Ref			Ref		
	No	0.87	0.57	1.33	1.03	0.61	1.76

*Adjusted for all variables in the table

4.4. Summary of findings by specific objectives

S.No.	Objectives	Summary of Main findings
1.	To assess the magnitude of under-five mortality in the community	The overall weighted under five, infant and neonatal mortalities with their corresponding 95% confidence intervals were: 42.76(39.56-45.97), 33.89(31.03-36.76) and 18.68(16.53-20.83) per 1000 live births, respectively. Majority of neonatal deaths occurred within the first seven days of life.
2.	To determine determinants of under-five mortality in the community	Among socioeconomic (distal) factors, maternal education, husband occupation and marital status of the mother were significantly associated with under-five and/or infant mortality. Among factors classified as environmental contamination; presence of separate kitchen was significantly associated with both under-five and infant mortality. Among personal illness control related factors: lack of post natal care, immunization status of the child and lack of vitamin A at least once after six months of age were significantly associated with higher rate of under-five mortality. Among factors related with child feeding and newborn care practices, ever breast feeding and delaying first bath at least for 24 hours were found to be significantly associated with low under-five mortality. Among other maternal and child related factors: short birth intervals, history of death of older sibling of the index child, being multiple birth, live birth after the index child were significantly associated with high under-five/infant mortality.
3.	To determine the association between child death & maternal mental distress	Mothers who lost their children had significantly high rate of mental distress compared with their counterparts. Similarly, mothers with child loss reported a significantly high rate of suicidal ideation (23.3%) than mothers without child death (16.3%) with p-value of 0.003.

5. Discussion

5.1. Magnitude and trends of under-five mortality

The overall weighted under five, child, infant, post neonatal and neonatal mortalities were calculated to be 42.76, 8.87, 33.89, 15.22 and 18.68 per 1000 live births, respectively. These figures are lower than the national and regional reports of the EDHS (4). The mortality rates identified by the current study are also lower than other pocket studies conducted in other parts of the country (53-56, 62). This may be because of socio-cultural differences in child caring and feeding practices of study populations. This was reflected by low prevalence of malnutrition (which is one of the leading causes of under-five mortality) in the study area (Zone) of the current study (172, 173). The other reason may be due to time variation between studies, as potential health service coverage has increased dramatically in the country in recent years. This was demonstrated by the current study that there were 100% coverage of at least one health post and one health extension worker operating in the study kebeles of the current study and almost all the kebeles had access of health centers' service within 10kms distance. However, still there might be under reporting of deaths (survivor selection bias) in the current study as most of the data were collected retrospectively in a longer duration (within the past seven years before the survey). Besides, the difference might be attributed to the difference in estimation method between the studies.

About 79% and 44% of all under-five mortalities occurred before their first birthday and within the first one month of age, respectively. Relatively, similar trend was observed in the 2011 EDHS report (4), in which 67% and 42% of all under-five mortalities occurred before their first birth date and within the first one month of age, respectively. The occurrence of high mortality especially during post neonatal period might be attributed to infection mainly from diarrheal disease, since this is the time when supplementary foods are started (given the poor hygienic condition of rural population of developing countries). Or it may be because of the ARI attributed to indoor air pollution as figured out by this study (lack of separate kitchen for cooking was associated with childhood mortality), as younger children are more likely to stay at home with their mother during cooking than older children.

On the other hand, about 82% of neonatal deaths occurred within the first seven days of life. This was in spite of the above mentioned high potential health coverage of the study kebeles. It may be because of poor quality of maternal and child health services provided to the community, as health service delivery systems in developing countries have been criticized for failing to bring expected results at expected level, partly because of poor quality (95). All those may signify the importance of investigating quality of health services to improve and strengthen maternal and child health interventions during pregnancy, during and immediately after birth (through ANC, skilled birth attendance and early post natal care). This may help to avert majority of neonatal mortalities, as early neonatal mortalities are mainly caused by pregnancy and child birth related problems; including birth asphyxia, prematurity, maternal hypertension and obstetric hemorrhage (174-176).

Significantly, higher rate of under-five mortality was encountered among rural kebeles than in urban kebeles. Similar observation was found in the EDHS report (4). This may be due to the relatively better access to health services and utilization of the services by urban population as a result of a relatively better awareness of the benefit of the health services.

Similar to the EDHS report (4), under-five mortality rate was significantly higher among males than in females in the current study. Similar finding was observed in a study which analyzed DHS data from sub Saharan African countries, including Ethiopia's EDHS 2011 data (177). This may be owing to biologic differences of the two sexes, as genetic factors were reported to be reasons for higher mortality among males than females (178-180).

Unlike other kebeles, under-five mortality significantly decreased in DSS kebeles during the study period. More or less similar trends were observed in infant and neonatal mortality, i.e. fluctuating trends in the overall and in non-DSS rural and urban kebeles, but sharp reduction in DSS kebeles. Relatively low under-five mortality was also observed in DSS kebeles than non-DSS kebeles. This may be due to effect of frequent contact of data collectors, supervisors and researchers with the community which is not true in non-DSS sites. This might create more concern and motivation of HEWs and other health cadres working in the kebeles, because they know that mortalities are continuously monitored by the Project. Or it might create awareness about service utilization and child care in the communities owing to frequent visiting and

questioning of the households to fill the questionnaires by data collectors of the Project. Previous study in India, revealed that, health education by visiting homes of the mothers had positive maternal behavior change that may positively affect child survival (181). Similarly, frequent home visit by lay volunteers was shown to improve treatment outcome of tuberculosis in Iraq (182). However, as DSS sites are becoming sources of evidence for magnitude and cause of mortalities in areas where vital event registrations are lacking (in Africa, Asia and Oceania) (183, 184), we suggest further investigation of whether such variations exist in other sites or not and the reasons for such variations. According to further personal communication of this finding with the Arba Minch DSS personnel, they are suspicious of under reporting of deaths in some DSS kebeles.

5.2. Determinants of under-five mortality

This study tried to identify determining factors of childhood mortalities by aggregating predicting variables to different relevant levels in order to determine unbiased effects of identified factors. To achieve that, efforts like matching of cases and controls and using appropriate analytical methods, including weighted conditional logistic regression by ruling out presence of clustering of the data during analysis were made.

Among distal factors maternal education was shown to be important determining factor of under-five and infant mortality. Both infants and under-five children of mothers who were at least grade nine had less odds of death than those who lacked formal education. This finding is in line with many other studies conducted in different parts of the world (66, 78, 90, 91). A study which analyzed the three EDHS data (2000, 2005& 2011) (92) also demonstrated the same. This may be because of the effect of maternal education on modern health knowledge, beliefs and practices of the mother, that in turn could have effect on the effectiveness of health behavior (feeding practices, child care etc.); and changes the mother's role in the family, enabling her to take the necessary measures to prompt child health, including effective use of modern health services (93).

Another important distal factor identified as predicting factor of under-five mortality was husband's occupation. Children whose fathers were daily laborers had higher rate of odds of death than those whose fathers were farmers. This may be due to the fact that occupation of the

father is an indicator of socioeconomic status of the household and stability of the family. It is logical to expect being a farmer is better and stable economically than being daily laborer, provided that majority of the current study population were from rural kebeles.

Both infants and under-five children whose mothers were separated/ divorced or widowed were more likely to have higher rate of odds of death than whose mothers were married. This was in line with other studies done in Africa that, children of married mothers were more likely to survive than unmarried ones (56, 74, 185). This may be for obvious reason that, those mothers without marital union are more likely to be deprived of economically than those who have husbands, because of lack of support from husbands, who are responsible for income of the household. Besides, married mothers would get support from their partners for utilization of health services during antenatal through to postnatal care. On the other hand, the insignificant effect of being single on under-five mortality observed in this study may be because of the fact that, single mothers are more likely to live with their parents and get the support to care for their children.

In this study, unexpectedly wealth index of the household was not statistically associated with under-five mortality. This was in contrast to other studies (130, 177, 186). However, the current finding was in line with many studies from developing countries, where they showed non-significant effect of socio economic status of the individual household on under-five mortality (28, 54, 74, 158, 187). This may be because of the definition of socio-economic status, as socio economic status was determined using principal component analysis of possession of household assets. Therefore, there may be under reporting of household assets by study participants as this is usually perceived to be linked with taxation and eligibility for social supports by the government and non-government organization in the community.

Maternal decision power as measured in the current study was not statistically significantly associated with under-five mortality. This was in contrast to previous arguments of positive effect of maternal status on childhood mortality through its effect on her decision on child health (85, 86, 89). However, unclear correlation between women's empowerment (participation in decision-making processes) in the household and childhood mortality was reported by another study (90). This may show that, mere decision power of the mother may not have effect on

childhood mortality unless it is supported by awareness about her and the child's health. However, the difference may be because of the difference in defining maternal power, as educational status of the mother is a crucial element of her status in the household, but it is treated independently (as a separate factor) in the current study.

In developing countries, traditional use of household energy like cooking and heating with biomass fuels/coal is posing a serious threat to health by producing a variety of health damaging pollutants (188) and is shown to be a risk factor for many causes of childhood mortalities (70, 189). It was also shown to be a risk factor for childhood mortality (68, 69). This was supported by the current study that, among factors classified as environmental contamination; presence of separate kitchen for cooking (which is a proxy indicator of indoor air pollution) was significantly associated with low under-five mortality. Similar effect was observed during the first year of the child. The odds ratio identified in the current study may be under estimated, as the child is expected to be at the back of his/her mother during cooking even though she is cooking in a separate kitchen. Almost all (99.7%) of households of the current study were using wood, animal dung or charcoal as source of fuel for cooking.

Presence or type of latrine facility the household had and source of drinking water were not significantly associated with childhood mortality in this study. This finding was against others' arguments (65, 190) and findings (66, 185) of a positive association between latrine facility and childhood mortality. However, our finding is in line with other studies (158, 187, 191). This may be because of the fact that majority of latrine types in the study area were traditional pit latrines (92% were pit latrines) which are usually unclean and prone to contamination by vectors such as house flies, this may be a risk factor for those children who had improved latrine as they are more likely to use similar ground at least for playing. The other possible explanation may be, because of access of curative health services at community level for those illnesses which may arise from lack of latrine facilities or safe drinking water such as diarrhea, through health extension program, as all kebeles of the current study had a health post with at least one health extension worker serving the community at grass root level. However, the effect of these factors on intermediate cause of child mortality such as diarrheal disease should not be ignored as their effect on the non-death outcomes of the child's health (nutritional status, growth, mental development etc) is of paramount importance (192, 193).

Among maternal and child related factors, previous birth interval was significantly associated with both under-five and infant mortality. Children who had longer birth intervals had less odds of mortality than those children who had birth interval of less than 24months. Many studies in developing countries also showed inverse association between the length of preceding birth interval and childhood mortality (62, 78, 90, 132, 194). This may be because of maternal depletion, as women with short intervals between two pregnancies have insufficient time to restore their nutritional reserves, a situation which is thought to adversely affect fetal growth, resulting in a low birth weight or small for gestation (134) which are shown to have a negative effect on child survival (131). Competition for resources among the siblings may be another explanation. Therefore, this finding strengthens the prominence of WHO's recommendation of at least 24 months spacing (134) by advocating and strengthening family planning methods.

History of death of older siblings of the index child was shown to significantly increase the odds of mortality among both under-five children and infants. Similarly, higher risk of childhood mortality was reported among children who reported death of an older sibling by other studies (92, 185, 195, 196). This may be because of the fact that, factors responsible for the previous child death in the household sustain and result in the death of the index child.

Multiple births are relatively rare events compared to singleton births, but reported to be a risk factor for childhood mortality particularly in resource limited settings (28, 92, 197, 198). Similarly, in the current study, those under-five children whose births were multiple had higher rate of odds of mortality than those who were single birth. Similar effect was observed among infants. So, these findings may indicate the importance of meticulous identification and investigation of high risk pregnancies, including multiple pregnancy during prenatal period in order to take appropriate action.

History of live birth after the index child was examined only for under-five mortality in order to account for the time required to give birth after birth of the index child. And it was significantly associated with under-five mortality that, under-five children of mothers with history of birth after the index child had higher rate of odds of mortality than those without. That may be because of resource competition for feeding and care. However, birth after index child may be a consequence to replace dead child rather than a cause.

Among factors related to child feeding and newborn care practices, history of ever breast feeding was found to be significantly associated with low under-five and infant mortality. Breast feeding has been reported to be as a major determinant of childhood health and mortality (22, 108, 119, 199). As a result, promotion of breast feeding is considered to be a key component of child survival strategy in many developing countries (113). Even though, the problem of residual reverse causality couldn't be ruled out (because of the design of this study), the finding of this study support the promotion of breastfeeding as a strategy for better child survival in developing countries like Ethiopia.

In this study, exclusive breast feeding status of the child and history of bottle feeding were not significantly associated with under-five mortality. Similarly, insignificant association was observed by another study (200). Non-significant difference of mortality among exclusively breast fed children and pre-dominantly breast fed children was reported by another study too (199). Problem of breast feeding, which may be a proxy indicator of lack of exclusive breastfeeding was also not associated with childhood mortality (122). This may be because of rareness of these practices, as exclusive breast feeding is not widely practiced that, only 32% of Ethiopian infants 4-5 months were reported to be exclusively breast fed (4). And only 10% of the children in the current study were bottle fed.

In this study, delaying first bath of a child at least to 24 hours after birth was shown to reduce odds of under-five mortality by 50% and infant mortality by 54%. Delaying first bath was considered to be newborn thermal care at delivery and the current finding strengthens the importance of WHO's recommendation of delaying first bath of a child after 24 hours (201).

Infants who had at least four ANC follow-up during their pregnancy had less odds of mortality than those infants who lacked ANC follow up. Though it was not significant, similar effect was observed among under-five children. Even though it was not statistically significant, experience of even less than four ANC follow up during pregnancy of the index child was shown to reduce odds of under-five and infant mortality. Similar protective effect of ANC follow up was observed by other studies (101, 103). This time (pre-natal period) is critical for the mother and the fetus that, it helps to identify high risk pregnancy including multiple pregnancy (which is shown to be a risk factor) for appropriate action.

Both mothers and their newborns are vulnerable during the postnatal period and provision of PNC services at this period is expected to prevent maternal and child morbidity and mortality (202, 203). This time is crucial not only to treat complications arising from delivery, but also to provide women with important information on how to care for themselves and their children. In support of this, in the current study lack of PNC was found to increase the odds of mortality by about 2.3 folds during the first five years of age and by about 2.4 folds during the first year of age of the child. This finding is in line with another study (204), which analyzed Demographic and Health Survey data from sub-Saharan African countries.

In contrast to reports of other studies (66, 101) about positive effect of institutional or skilled attendance of delivery on childhood mortality, place and attendance of delivery of the index child were not significantly associated with under-five mortality in the current study. However, institutional delivery was also not a protective factor for child survival by other studies conducted in Ethiopia (62, 158). Besides, lack of significant association between delivery at hospital or skilled attendant and neonatal mortality was reported by another study (131). This may be due to the fact that complicated cases were more likely to come for institutional delivery than to stay at home. However, health service delivery systems in developing countries are criticized for failing to bring the expected health benefits at expected level, partly because of dysfunctional health services (95). So, these findings may warrant investigating the quality of delivery services being provided by health facilities in the study areas.

Immunization is the most effective child-survival intervention to date and the immunization status of children was reported to be an important factor for survival (66) with its greater impact in communities with low socioeconomic status (205). Similarly, in the current study, immunization status for age of the child was significantly associated with under-five and infant mortality. The odds of death of under-five children were, about 3.6 times if they were partially immunized and about 11 times if they were not immunized at all, compared to those fully immunized. Similar protective effect of immunization was observed among infants. The current expanded program on immunization of Ethiopia calls for BCG vaccine at birth, three doses of pentavalent (Diphtheria and Tetanus and Pertussis and Haemophilus influenzae and Hepatitis B) vaccine and pneumococcal conjugate vaccine at 6, 10, 14 weeks of age, four doses of oral polio

vaccine at birth, 6, 10, 14 weeks of age, inactivated polio vaccine at 14 weeks of age and measles vaccine at 9 months of age and Rotavirus vaccine at 6, 10 weeks of age (206).

Similar to immunization status, the odds of under-five and infants deaths were high among children who lacked vitamin A at least once after six months of their age than those who took. Vitamin A supplementation is another child health intervention and reported to reduce childhood mortality attributed to diarrhea and measles (105, 207). Both the above findings ratify the importance of strengthening of those interventions for sustenance of the reduction of childhood mortality for the attainment of child health related SDGs target.

5.3. Effect of child death on maternal mental distress

Although studies conducted in the country assessed the magnitude of CMD among postpartum mothers (162) and the effect of maternal mental distress on child wellbeing (208, 209), none of them tried to assess the effect of child death on maternal mental health status. This study shed light on the problem by assessing the effect of child loss on maternal mental distress.

This study demonstrated that, child loss has significantly associated with maternal mental distress. Mothers who lost their child reported a significantly high rate of mental distress than their counterparts. Similarly, mothers with child loss reported a significantly high rate of suicidal ideation than mothers without child death. This finding is consistent with previous studies elsewhere (43, 210). Similarly, high rate of hospitalization for psychiatric illnesses was reported among mothers with child loss than those without (40). This may be an indication that mothers with child loss are prone to even severe mental illnesses that need hospitalization and that warrants mental health intervention for mothers with child loss by integrating mental health services to maternal and child health services.

The effect of child loss on maternal mental distress was greater during the earlier periods (within six months of child death) and it decreases through time. However, it was shown to be persistently high at least during the first three years after child death than among mothers without child loss. Similar finding was observed by other studies (210, 211) that, mental distress among mothers with child loss persisted for a longer duration. It was reported to persist up to 30 months after child death (210). Risk of hospitalization for any psychiatric disorder was reported to

remain significantly high among mothers who lost their child even after five years of child death (40). This persistent maternal mental distress after child loss may have impact on the subsequent children of the mother, which may lead to a vicious cycle of the problem. Previous studies revealed significant association between history of death of older sibling of the child with the death of index child (185, 195, 196). It was also shown that child wellbeing was significantly associated with maternal mental distress (12, 13). All these point out the importance of mental health interventions targeting mothers with child loss not only for the mother, but also for her children.

This study also revealed other determinants of mental distress among overall mothers. Overall, mothers from households of average and rich wealth index had about 59% and 69%, respectively, less odds of mental distress than those from poor categories. Similar finding was observed by other studies (212, 213), that poor women were more likely to have postpartum depression than rich ones. That may be as a result of stress, worries and insecurities in feeding and sheltering the families in general and children in particular or due to the situation that poor mothers are living with as they are more likely to live in crowded or stressful conditions and have less occupational opportunities.

Mothers who reported to have other medical problems (including chronic illnesses such as diabetes mellitus, hypertension etc…) were more likely to have mental distress than those without. This fact was established by another study of postnatal mothers (212) that, presence of other medical illness was significantly associated with mental distress. Similar finding was observed by another study of the general population (214). Bidirectional link between mood disorders and medical illnesses was confirmed by a scientific review of literatures (215). It was also reported that mood disorders affect the course of medical illnesses (215). All those may signify the importance of integrating mental health interventions (including screening, counseling and referral of those in need) with management of other medical problems.

Mothers who reported seeking health services from modern health system had less odds of mental distress than those who consulted traditional means. In line with this, mothers who had ANC follow up during the pregnancy of the index child had less odds of mental distress than those who didn't. These may be because of the benefit of the general counseling provided by

health workers on general health of the mother and the child. This may be a clue for the benefit that might be extracted by such mothers if mental health related counseling is integrated with maternal health services, including during ANC follow up, this may help mothers to cope with the stressful events they may face.

6. Internal Validity and generalizability of the study results

Different observational epidemiologic study designs were implemented in this study, including: simple cross-sectional (census), case control and comparative cross-sectional study designs. Observational study designs are criticized to be prone to bias such as confounding problems. Evidence obtained through observational studies is considered to be weak compared to information from randomized trials. However, due to ethical issues, feasibility and cost associated with experimental studies, observational studies continue to be the common epidemiologic designs implemented in Public Health and provide valuable evidence for public health actions (216). In addition, findings from observational studies can be used as initial steps for experimental studies.

The sample size of the study is an important factor to achieve enough power for a given study to reach reliable findings and to detect existing differences between two interventions/groups. Studies included in this work, included adequate sample size calculated using appropriate statistical methods and assumptions. For the simple cross-sectional study, 20,161 participants identified from the census and Arba Minch DSS database were included to determine magnitude and trend analysis of under-five mortality. For the case control and comparative cross-sectional studies the required sample size was calculated using appropriate statistical method by considering 95% of confidence level and 80% of power and by adjusting for design effect. The response rate for case control study was almost 100%. For that of comparative cross-sectional study it was also very high (98.3%).

Results from epidemiologic studies in general and observational studies in particular often appear to suffer from two types of errors i) random errors (chance) and ii) systematic errors (bias). Random error can be reduced by having adequate sample size and as explained above studies in this assessment included adequate sample size. Besides, the role of chance can be assessed and estimated using statistical techniques (significance tests and confidence intervals). In all studies of this thesis, the role of chance was quantified and reported using appropriate statistical methods including weighted conditional logistic regression as appropriate and P-value with a cut-off point of ≤ 0.05 was taken as indicator of presence of significance.

The three main sources of systematic errors (bias) are: selection bias, information bias, and confounding. With regard to selection bias, the studies in this thesis applied either census (selection of the total sampling units) or using probability selection. For example, census was applied in the case of selection of kebeles in urban District and inclusion of all study subjects in the determination of magnitude of under-five mortality in all kebeles. In selection of kebeles in rural District and selection of study participants for the case control and comparative cross-sectional studies, simple random sampling technique was applied. However, purposive selection of the two Districts of the Zone could introduce some selection biases in representing the population of the Zone. But, the wide agro ecological nature (Dega (high land), Woinadega (mid land) and Kola (low land)) of Arba Minch Zuria District may enable us to represent the population of the Zone, because other Districts of the Zone are more or less within these categories of Agro ecological/climatic zones. Besides, Arba Minch Town is the capital of the Zone and residents of the Town mainly are from different Districts of the Zone. In addition, we have applied weighted analysis in all cases to account for unequal selection probability.

The main sources of information bias in epidemiologic studies include: observer bias, respondent bias (such as recall bias, a socially desirable response or intentionally biasing of information by respondents) and instrument bias (related to the instrument used for measuring information, including the questionnaires and the procedures). To minimize information bias in this study, effort such as selection of experienced data collectors and provision of extensive training to the data collectors on the questionnaires and the procedures were made. The data collection instruments were back translated to check their consistency and all of them were pre-tested. Besides, standardized and validated questionnaire (WHO's SRQ-20), which was shown to have good validity as an indicator of CMD in Ethiopian setting, was used for the comparative cross-sectional design. In order to have genuine response of the study participants, the data collectors explained the objective of the study and confidentiality of the response to the participants.

On the other hand, one of the possible sources of information bias in this study could be in determining date of birth and death of the child, especially in non-DSS kebeles. This is one of the main challenges of mortality studies in developing countries where regular registrations of vital events are lacking. The situation in Ethiopia is the same, even though the Government of Ethiopia very recently (since August, 2016) has started to introduce the scheme in the country

which is critically vital for future studies. In order to minimize the biases, the dates in the current study were collected from child immunization cards/ birth certificates or health post register or determined using local calendars in the absence of confirmed/registered dates. Indexing technique of children whose date of birth was known with those who were in similar age but lack register in the household or in the neighboring households was additional strategy applied in determining the dates. Because of recall and selective omission biases (tend not to report deaths mainly those of early deaths), underestimation of childhood mortality is possible. In order to minimize the bias, the information was collected with the help of HEWs or health post register and local leaders. HEWs know the households in their respective kebeles very well, as they are permanent residents of the kebele and register all households in the kebele and events that are occurring in these households as part of their day to day activities (however, there were variation among kebeles in this regard). Strict follow up of the whole process (data collection to data entry and cleaning) was undertaken by the principal investigator. With all these efforts, however, some recall and social desirability biases could not completely be avoided. As discussed above (in discussion), these may affect some of the findings such as, in estimating magnitude of mortality and in determination of wealth index (under estimation of both).

As mentioned above, other sources of bias in epidemiologic studies are confounding and/or effect modification. Design and analysis level techniques have been developed for epidemiological studies to control effects of confounding. In this study, some confounders were addressed at design level by matching cases and controls for the case control study and exposed and unexposed for the comparative cross-sectional study (matched for age of the child and place of residence). Matching of the two groups by place of residence, might allow us to control known and unknown kebele level variables which were associated with the outcome and the predictors. In both designs, conditional logistic regression was used to control other possible confounders after assessing presences of clustering of the data. Presence of effect modification/interaction between the predictors was assessed by including the interaction term of the suspected variables in the respective models.

With regard to representativeness and generalization of the findings, in addition to the application of probability sampling to select the study kebeles and participants, both urban and rural populations were represented. Even though the two districts were selected purposively, we

assumed that the Arba Minch Zuria District and Arba Minch Town are appropriate to represent the population of the Zone. Besides being the study site of the Arba Minch DSS, Arba Minch Zuria District is suitable to have representative sample of the Zone as it constitutes kebeles distributed in different agro ecological and climatic conditions. Arba Minch Town is the capital of the Zone and home to population from different districts of the Zone. The study areas of this study were similar with not only to the other Districts of Gamo Gofa Zone, but also to most of the rural communities in Ethiopia in terms of demographics, health services, road access, and economic structure. This may allow the findings of this study to be generalized to other areas of the country, especially to communities with similar backgrounds. Accordingly, the findings can be used in the design of health interventions to target health problems of under-five children to sustain reduction of mortality beyond MDGs and attain SDGs' targets. The comparative cross-sectional study also highlighted the importance of integration of simple mental health interventions to the existing maternal and child health services in the country to tackle the profound maternal mental health problems, especially after child loss which may have devastating impact on future children of the mother and her families in particular and on the wellbeing of the nation in general.

7. Strengths and limitations of the study

The main strength of this study includes inclusion of large sample size, especially for the study of the magnitude of under-five mortality. It also included population from urban and rural, from DSS and non-DSS sites and from different agro-ecological kebeles, unlike previous studies in the country. It applied as well appropriate statistical methods to account for the non-proportional allocation of the study participants across urban and rural settings. Besides the age, matching the two groups of the case control and comparative cross-sectional studies by place of residence might help to control known and unknown kebele level variables, including variables that may be difficult to be accounted for during analysis, because of their unobvious nature. In addition, this study is the first of its kind to assess the other dimension of child mortality, its effect on maternal mental health, which is shown to affect child survival.

However, because of the observational nature of the study designs applied in this study, some systematic errors, such as recall and social desirability biases could not be completely avoided. For example, the response of the respondents about household assets, mothers' decision power in the household could be prone to social desirability biases. To minimize such biases, data collectors explained the objectives of the study and confidentiality of the responses. This was emphasized during training of data collectors and during supervision. The recall bias that might be attributed to recalling the date of birth of the child was minimized by using immunization card of the child or health post register. If the child was not immunized or the immunization card was lost, we utilized local calendars and indexing with the help of HEWs.

Besides, there might be under reporting of deaths (survivor selection bias), especially for early child deaths, which may underestimate the rates. This was a problem in DSS sites too (personal observation and communication of the principal author as he worked as the coordinator of the Arba Minch DSS). To minimize this problem, besides the house to house visit, the information about child death was confirmed from HEWs of the kebele and local leaders or health development army of the locality. In order to minimize the recall bias that might be attributed to recalling variables such as related to child feeding, new born care practice, health service use, etc of the mother, we collected information within the past three before the survey (March 01, 2011 and September 30, 2014) and included the youngest child whenever possible. Finally, because

of the nature of the design, temporal relationship between child death and maternal mental distress couldn't be established in the current study.

8. Conclusions

The overall weighted under five, infant and neonatal mortalities with their corresponding 95% confidence intervals were: 42.76(39.56-45.97), 33.89(31.03-36.76) and 18.68(16.53-20.83) per 1000 live births, respectively. The under-five mortality in the study area was lower than previous national and regional reports. Nevertheless, it is reckoned that significantly high numbers of children are dying during their early days of life.

Distal factors, such as maternal education, husband occupation and marital status of the mother were shown to significantly affect childhood mortality by operating through proximal factors. Among factors classified as environmental contamination; presence of separate kitchen was significantly associated with both under-five children and infant mortalities. Lack of post natal care, lack of immunization and lack of vitamin A supplementation at least once after six months of age were personal illness control related factors which significantly associated with higher rate of under-five mortality. Among factors related with child feeding and newborn care practices, lack of breast feeding and delaying first bath at least for 24 hours after birth were found to be significantly associated with under-five mortality. Previous birth interval, history of death of older sibling of the index child, being multiple birth, live birth after the index child were other maternal and child related factors which significantly associated with under-five mortality.

Significantly high proportions of women with child loss in this study were experiencing mental health problems than those without child loss, including higher rate of suicidal ideation. Even though the effect was shown to decrease through time, it persisted significantly high for relatively longer duration (at least three years after child death). With regard to other factors which were associated with maternal mental distress, those mothers who lacked ANC follow up during pregnancy of the index child were shown to have high rate of mental distress than those who had. Significantly high rate of mental distress was also observed among mothers from poor households and who reported to have other medical illnesses.

9. Recommendations

9.1. Operational

As distal factors such as maternal education, husband occupation and marital status of the mother were shown to be significantly associated with under-five mortality, in order to maintain the reduction in childhood mortality, investing on maternal education by targeting those at risk groups is highly commendable.

Owing to previous birth interval was shown to be significantly associated with under-five mortality, advocating delaying inter-birth interval at least for 24 months by promoting family planning is crucial to maintain reduction of under-five mortality for the attainment of the SDG targets.

In order to minimize the effect of indoor air pollution, health care providers such as HEWs should teach and encourage mothers to have separate kitchen for cooking, which was shown to significantly reduce odds of under-five mortality.

Health service providers should strengthen delaying first bath of a child at least for 24 hours after birth as one of the strategies for a newborn thermal care at delivery. This should also be one of the focuses of health education programs of health facilities and providers to create awareness of the community in general and the mothers in particular, as most of deliveries are happening at home, attended by traditional birth attendants or relatives.

In order to sustain reduction in under-five mortality, health providers in general and HEWs in particular should strengthen promotion of maternal child health services, such as family planning, ANC, PNC, immunization and vitamin A supplementation.

As significantly high proportions of women with child loss were experiencing mental health problems than those without child loss, including higher rate of suicidal ideation, assessment of mothers for mental distress, especially for those who lost their children during post natal visit or home visit by health service providers in general and HEWs in particular may help to reduce the negative impact of mental distress in such mother's future children and in her family. Integration

of mental health interventions (such as screening, counselling and referral of those in need) with other maternal and child health services may help to reduce the impact.

As mothers with other medical illnesses were more likely to have high rate of mental distress, health service providers need to be aware/sensitized of this link and should screen those mothers for possible mental disorders for appropriate action.

9.2. Policy implication

As significant numbers of children are dying during their early days of life in spite of high potential health service coverage, investigation of quality of health services and strengthening of maternal and child health interventions during pregnancy and during and immediately after birth may help to avert majority of neonatal mortalities.

In line with production and distribution of electricity to reach all households, advocacy to have separate kitchen for cooking (which was significantly associated with low under-five mortality), is commendable given that majority of the households of the study area were using traditional way of household energy sources like biomass fuels for cooking.

Promotion of maternal and child health services, such as family planning, ANC, PNC, immunization, supplementation of vitamin A should continue as strategies to maintain reduction of childhood mortalities and attainment of child health related SDGs target.

Consideration of screening of maternal mental health problems by incorporating simple common mental distress assessing tools, such as SRQ into the maternal and child health care programs of health facilities may have significant impact in reducing the impact of maternal mental health problems in the communities.

As significantly high rate of mental distress was observed among mothers from poor households, investing on household income generation activities may be taken as one of the measures for tackling maternal mental health problems in the communities.

9.3. Further research

As difference in magnitude and trend in childhood mortality in DSS and non-DSS kebeles was observed in this study, more rigorous studies focusing on the actual reasons of the difference need to be conducted, as DSS sites are becoming sources of evidence for magnitude and cause of mortalities in areas where vital event registrations are lacking (in Africa, Asia and Oceania)**.** Besides, we suggest further investigation of whether such variations exist in other sites or not and the reasons for such variations.

In line with other studies in the country, this assessment showed insignificant association between institutional delivery and skilled birth attendant and under-five mortality, so investigation of the quality of delivery services being provided by health facilities may be helpful for further action.

The association between child loss and maternal mental distress is not well investigated in Ethiopia. As search of literatures on this area confirmed, the current study is the first in its kind in the country, so it is of paramount importance to further investigate the association by using stronger designs.

Studies exploring the feasibility and effectiveness of provision of simple psychosocial interventions, such as screening for maternal mental distress using simple screening tools like SRQ, basic counseling and emotional support by front line health workers such as HEWs in Ethiopia are essential.

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11.References

1. World Health Organization. World Health statistics, Geneva. 2016.
2. Unite Nation Inter-agency Group for Child Mortality Estimation ((UN IGME). Levels & Trends in Child Mortality, 2015. http://www.data.unicef.org/fckimages/uploads/1410869227_Child_Mortality_Report_2015.pdf Accesssed on August 2016. .
3. UNICEF. The State of the World's Children 2016: A fair chance for every child. 2016.
4. Ethiopia Demographic and Health Survey. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ORC Macro 2011. 2011.
5. Central Statistical Agency (CSA) [Ethiopia] and ICF. Ethiopia Demographic and Health Survey 2016: Key Indicators Report. Addis Ababa, Ethiopia, and Rockville, Maryland, USA. CSA and ICF. 2016.
6. WHO-Regional Office for Europe. Impact of economic crises on mental health. 2007. Copenhagen, Denmark.
7. Mayosi BM, Flisher AJ, Lalloo UG, Sitas F, Tollman SM, et al. The burden of non-communicable diseases in South Africa. Lancet. 2009, 374: 934-947.
8. World Health Organisation Department of Health Statistics and Informatics. The global burden of disease 2004 update. Geneva: WHO Press. 2008.
9. Fisher J, Mello CD, Patel V, Rahman A, Tran T, et al. Prevalence and determinants of common perinatal mental disorders in women in low- and lower-middle-income countries: a systematic review. B World Health Organ. 2012, 90: 139–149.
10. Walker SP, Wachs TD, Gardner JM, Lozoff B, Wasserman GA, et al. Child development: risk factors for adverse outcomes in developing countries. Lancet. 2007, 13(369): 145–157.
11. WHO, Department of Mental Health and Substance Abuse. Maternal mental health and child health and development in low and middle income countries : report of the meeting held in Geneva, Switzerland, 30 January - 1 February, 2008.
12. Patel V, Rahman A, Jacob KS, Hughes M. Effect of maternal mental health on infant growth in low income countries: New evidence from South Asia. BMJ. 2004;328:820–823.
13. Rahman A, Lovel H, Bunn J, Iqbal Z, Harrington R. Mothers mental health & infant growth: a case-control study from Rawalpindi, Pakistan. Child Care Health Dev. 2003, 30: 21–27.
14. King-Hele S, Webb RT, Mortensen PB, Appleby L, Pickles A, KM. A. Risk of stillbirth and neonatal death linked with maternal mental illness: a national cohort study. Arch Dis Child Fetal Neonatal Ed. 2009;94(2):105-10.
15. Cooper PJ, Murray L, Wilson A, Romaniuk H. Controlled trial of the short- and long-term effect of psychological treatment of post-partum depression. Brit J Psychiat. 2003, 182: 412–419.
16. *World Health organization.* Department of Mental Health and Substance Abuse. Improving Maternal Mental Health. Geneva. 2008.
17. Forrest GC, Standish E, Baum JD. Support after perinatal death: a study of support and counselling after perinatal bereavement. *BMJ* 1982; 285**:** 1475–79.
18. Ethiopian Federal Ministry of Health (FMOH), Maternal and Child Health Directorate Federal Ministry of Health. National Strategy for Newborn and Child Survival in Ethiopia, 2015/16 - 2019/20. Addis Ababa, Ethiopia, 2015.

19. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. 1984. Bulletin of the World Health Organization. 2003;81(2):140-5.
20. Davis K, Blake J. Social structure and fertility: An analytic framework. *Economic Development and Cultural Change*. 1956;4:211-35.
21. Bongaarts J. A framework for analyzing the proximate determinants of fertility. *Population and Development Review* 1978. 1978;4:105-32.
22. Girma B, Berhane Y. Children who were vaccinated, breast fed and from low parity mothers live longer: A community based case-control study in Jimma, Ethiopia. BMC Public Health. 2011;11(1).
23. Kedir Teji, Yadeta Dassie, Nega Assefa, Tesfaye Gobena. Determinants of Infant Mortality in Kersa District, Eastern Ethiopia: A Case Control Study. Presented on World Federation of Public Health, Addis Ababa Ethiopia, 2012. URL:https://wfpha.confex.com/wfpha/2012/webprogram/Paper10261.html.
24. Osuorah D, Antai D, Ezeudu C, E. C. Effect of maternal exposure to intimate partner violence on under-five mortality in Nigeria. . Nigerian Journal of Paediatrics, 2012.39(3):97-104.
25. Mutunga CJ. Environmental Determinants of Child Mortality in Kenya. World Institute for Development Economic Research (UNU-WIDER), 2007 2012/10/24/12:33:25. Report No.
26. Ogbe JO. Exclusive Breast Feeding and Children Immunization as Demographic Determinants of Child Mortality in Delta State. . Pakistan Journal of Nutrition 2008;7(1):35-9.
27. Kumar. PP, File. G. INFANT AND CHILD MORTALITY IN ETHIOPIA: A STATISTICAL ANALYSIS APPROACH. . Ethiop J Educ & Sc 2010;5(2):51-7.
28. Kembo J, Jeroen K. Van Ginneken. Determinants of infant and child mortality in Zimbabwe: Results of multivariate hazard analysis Demographic Research 2009;21(13).
29. Billings A. C. and Moos R. H. Stressful life events and symptoms: a longitudinal model. *Hlth Psvehol.* 1982, 1(2), 99.
30. Myers J. K., Lindenthal J. J., Pepper M. P. and Ostrander D. R. Life events and mental status: a longitudinal study. *J. Hlth Soc. Behat'.* 1972, 13(4), 398.
31. *Paykel E. S., Myers J. K., Dienelt M. N., Klerman G. L., Lindenthal J. J. and Pepper M. P. Life events and depression: a controlled study. Arch. Gen. Psychiat. 1969, 21, 753-760.*
32. Pianta R. C. and Egeland B. Relation between depressive symptoms and stressful life events in a sample of disadvantaged mothers. *J. Consult. Clin. Psychol.* 1994, 62(6), 1229
33. Fergusson DM, L. John Horwood, Joseph M. Boden. Abortion and mental health disorders: evidence from a 30-year longitudinal study. The British Journal of Psychiatry. 2008;193:444-51.
34. Vachon, M. L. S., Rogers, J., Lyall, W. A. L., Lancee, W. J., Sheldon, A. R., & Freeman, S. J. J. Predictors and correlates of adaptation to conjugal bereavement. American Journal of Psychiatry, 1982, 139, 998-1002.
35. Zisook S., Shuchter S. R., Sledge P. A., Paulus M. P. and Judd L. L. The spectrum of depressive phenomena after spousal bereavement. *J. Clin. Psyehiat.* 1994, 55(4) (Suppl.), 29.
36. Bornstein P. E., Clayton P. J., Halikas J. A., Maurice W. L. and Robins E. The depression of widowhood after thirteen months. Br. J. Psychiat. 1973, 122, 561
37. Stroebe W., Stroebe M. S. and Domittner G. Individual and situational differences in recovery from bereavement: a risk group identified. *J. Soc. Iss.* 1988, 44(3), 143
38. Green, B. L. Defining trauma: Terminology and generic stressor dimensions. Journal of Applied Social Psychology. 1990, 20, 1632-1642.

39. Rando,T. A. (1996). Complications in mourning traumatic death. In K. Doka (Ed.), Living with grief after sudden loss(pp. 139-159).Washington, D.C.:Taylor and Francis.
40. Jiong Li, Thomas Munk Laursen, Dorthe Hansen Precht, Jørn Olsen, and Preben Bo Mortensen. Hospitalization for Mental Illness among Parents after the Death of a Child. N Engl J Med 2005;352:1190-6.
41. J. C. Vance, J. M. Najman, M. J. Thearle, G. Embelton, W. J. Foster and F. M. Boyle. Psychological Changes in Parents Eight Months After the Loss of an Infant From Stillbirth, Neonatal Death, or Sudden Infant Death Syndrome --A Longitudinal Study. *Pediatrics.* 1995;96;933-938.
42. Clarke M. and Williams A. J. Depression in women after perinatal death. *Lancet* 916, 1979.
43. Vance J. C., Foster W. J., Najman J. M., Embelton G., Thearle M. J. and Hodgen F. M. Early parental responses to sudden infant death, stillbirth or neonatal death. *Med. J. Aust.* 1991, 155, 292.
44. Davidson GW. Stillbirth, neonatal death and sudden infant death syndrome. In: Wass H, Corr CA, editors. Childhood and death. Washington, DC: Hemisphere; 1995. pp. 243–260.
45. Surkan, P. J., Rådestad, I., Cnattingius, S., Steineck, G. and Dickman, P. W. Events after Stillbirth in Relation to Maternal Depressive Symptoms: A Brief Report. Birth. 2008, 35: 153–157.
46. Frances M. Boyle, John C. Vance, Jake M. Najman & M. John Thearle. The mental health impact of stillbirth, neonatal death or Sudden infant death syndrome(SIDS): prevalence and patterns of distress among mothers. *Soc. Sci. Med.* 1996, 43(8), 1273-1282.
47. Rogers CH. "The Effect of the Death of a Child on Midlife Mental and Physical Health: An Exploration of Risk and Resilience Factors". Psychology Dissertations. Paper 8. URL: http://scholarworks.gsu.edu/cgi/viewcontent.cgi?article=1007&context=psych_diss. accessed August 10, 2015. Georgia State University. 2005.
48. Monroe S. M. and Depue R. A. Life stress and depression. In *Psychosocial Aspects of Depression* (Edited by Becker J. and Kleinman A.). Lawrence Erlbaum Associates, Hillsdale, N J, 1991.
49. Brown G. W. and Harris *T. Social Origins of Depression: A Study of Psychiatric Disorder in Women.* Free Press, New York, 1978.
50. Unite Nation Inter-agency Group for Child Mortality Estimation ((UN IGME). Levels & Trends in Child Mortality, 2014. http://www.data.unicef.org/fckimages/uploads/1410869227_Child_Mortality_Report_2014.pdf Accesssed on August 2016. .
51. Edward Fottrell, Fikre Enquselassie, Peter Byass. The distribution and effects of child mortality risk factors in Ethiopia: A comparison of estimates from DSS and DHS. Ethiop. J. Health Dev. 2009;23(2), 163-8.
52. Byass P, Worku A, Emmelin A, Berhane Y. DSS and DHS: longitudinal and cross-sectional viewpoints on child and adolescent mortality in Ethiopia. Popul Health Metr. 2007;5:12.
53. Adewuya AO, Hanlon C, Medhin G, Dewey M, Alem A, Worku B, Prince M. Perinatal common mental disorders and child survival in Ethiopia. J Paediatr Child Health. 2014 Jan;50(1):57-63.

54. Okwaraji YB, Cousens S, Berhane Y, Mulholland K, Edmond K. Effect of geographical access to health facilities on child mortality in rural Ethiopia: a community based cross sectional study. PLoS One. 2012;7(3):e33564.
55. Amare D, Fasil T, Belaineh G. Determinants of under-five mortality in Gilgel Gibe Field Research Center, Southwest Ethiopia. *EthiopJHealth Dev*. 2007;21(2):117-24.
56. Biks GA, Berhane Y, Worku A, Gete YK. Exclusive breast feeding is the strongest predictor of infant survival in Northwest Ethiopia: a longitudinal study. Journal of Health, Population and Nutrition (2015) 34:9. DOI 10.1186/s41043-015-0007-z.
57. UNFPA/WHO. Maternal mental health and child health and development in resource-constrained settings: Report of a UNFPA/WHO international expert meeting: the interface between reproductive health and mental health Hanoi, June 21-23, 2007.
58. Lindemann, E. The symptomatology and management of acute grief'. American Journal of Psychiatry, 1944, 101, 141-148.
59. UNICEF, World Health Organization. Countdown to 2015: A Decade of Tracking Progress for Maternal, Newborn and Child Survival. The 2015 Report.
60. World Health Organization. Globa Health Observatory. Under five Mortality. 2015. URL: http://www.who.int/gho/child_health/mortality/mortality_under_five_text/en/. Accessed on August 2016.
61. Okwaraji YB, Cousens S, Berhane Y, Mulholland K, Edmond K. Effect of Geographical Access to Health Facilities on Child Mortality in Rural Ethiopia: A Community Based Cross Sectional Study. PLoS ONE. 2012. 7(3): e33564. doi:10.1371/journal.pone.0033564.
62. Yigzaw M, Enquselassie F. Birth Spacing and Risk of Child Mortality at Kalu District South Wollo Zone of Amhara Region, North East Ethiopia. Ethiop Med J. 2010;48(2):105-15.
63. Yaya Y, Eide KT, Norheim OF, Lindtjørn B. Maternal and Neonatal Mortality in South-West Ethiopia: Estimates and Socio-Economic Inequality. PLoS ONE. 2014, 9(4): e96294. doi:10.1371/journal.pone.0096294.
64. United Nations (UN). *World Population Prospects: The 1996 Revision.* New York: Population Division, United Nations. 1996.
65. World Health Organization. World Health Report 2005: Make every mother and child count. Geneva. 2005.
66. Mondal NI, Hossain K, Ali K. Factors Influencing Infant and Child Mortality: A Case Study of Rajshahi District, Bangladesh. J Hum Ecol, . 2009;26(1):31-9
67. International Centre for Diarrhoeal Disease Research, Bangladesh (**ICDDR B).** Water, Sanitation and Hygiene Research Group, Centre for Communicable Diseases. Health and Science Bulletin. 2012;10(2).
68. Sutapa Bandyopadhyay Neogi , Shivam Pandey, Jyoti Sharma , Maulik Chokshi, Monika Chauha , Sanjay Zodpey, Vinod K Paul. Association between household air pollution and neonatal mortality: an analysis of Annual Health Survey results, India. WHO South-East Asia Journal of Public Health, 2015, 4 (1).
69. Diego G Bassani, Prabhat Jha, Neeraj Dhingra, Rajesh Kumar. Child mortality from solid-fuel use in India: a nationally representative case-control study. BMC Public Health 2010, 10:491.
70. Bruce NG, Dherani MK, Das JK, Balakrishnan K, Adair-Rohani H, Bhutta ZA, et al. Control of household air pollution for child survival: estimates for intervention impacts. BMC Public Health. 2013;13 Suppl 3:S8.

71. Uddin J, Zakir H. Predictors of Infant Mortality in a Developing Country. Asian Journal of Epidemiology. 2008;1(1):1-16.
72. Vos R, Ruth Lucia, Mauricio León, José Rosero, José Cuesta. Health. In: World Bank, and Inter-American Development Bank (2004) Ecuador: Creating Fiscal Space for Poverty Reduction. A Fiscal Management and Public Expenditure Review, Volume II, Report No. 28911-EC. Washington D.C. 2004.
73. Akinyemi JO, Chisumpa VH, Odimegwu CO. Household structure, maternal characteristics and childhood mortality in rural sub-Saharan Africa. Rural and remote health. 2016;16(2):3737.
74. Kanmiki EW, Bawah AA, Agorinya I, Achana FS, Awoonor-Williams JK, Oduro AR, et al. Socio-economic and demographic determinants of under-five mortality in rural northern Ghana. BMC international health and human rights. 2014;14:24.
75. Brockerhoff M., Hewett P. Inequality of child mortality among ethnic groups in sub Saharan Africa. Bulletin of the world health organization. 2000, 78(1).
76. Titaley C, M. J. Dibley, K. Agho, C. L. Roberts, J. Hall. Determinants of neonatal mortality in Indonesia. BMC Public Health. 2008;8:232.
77. Dyson T, Moore M. On Kinship Structure, Female Autonomy, and Demographic Behavior in India. Population and Development Review. 1983;9:1.
78. Nakamura H, Ikeda N, Stickley A, Mori R, Shibuya K. Achieving MDG 4 in sub-Saharan Africa: what has contributed to the accelerated child mortality decline in Ghana? PloS one. 2008;6(3):e17774.
79. Shroff MR, Griffiths PL, Suchindran C, Nagalla B, Vazir S, Bentley ME. Does maternal autonomy influence feeding practices and infant growth in rural India? Social science & medicine 2011;73(3):447-55.
80. ICPD. International Conference on Population and Development. 1994.
81. Cleland J. The benefits of educating women. The Lancet. 2010;376(9745):933-4.
82. Frost MB, Forste R, Haas DW. Maternal education and child nutritional status in Bolivia: finding the links. Social science & medicine. 2005;60(2):395-407.
83. Brunson EK, Shell-Duncan B, Steele M. Women's autonomy and its relationship to children's nutrition among the Rendille of northern Kenya. American Journal of Human Biology. 2009;21(1):55-64.
84. Hossain MB, Phillips JF, Pence B. The effect of women's status on infant and child mortality in four rural areas of Bangladesh. Journal of biosocial science. 2007;39(3):355-66.
85. Schmeer KK. Married women's resource position and household food expenditures in Cebu, Philippines. Journal of Marriage and Family. 2005;67(2):399-409.
86. Engle PL, Bentley M, Pelto G. The role of care in nutrition programmes: current research and a research agenda. The Proceedings of the Nutrition Society. 2000;59(1):25-35.
87. Mistry R, Galal O, Lu M. "Women's autonomy and pregnancy care in rural India: a contextual analysis". Social science & medicine (1982). 2009;69(6):926-33.
88. Saleem S, Bobak M. Women's autonomy, education and contraception use in Pakistan: a national study. Reproductive Health. 2005;2:doi: 10.1186/742-4755-2-8.
89. Fikree FF, Pasha O. Role of gender in health disparity: the South Asian context. BMJ : British Medical Journal. 2004;328(7443):823-6.
90. Economic Policy PaSOE, SPC and Macro International Inc,. Republic of the Marshall Islands Demographic and Health Survey. 2007:112-24.

91. Kandala N-B, Ji C, Stallard N, Stranges S, Cappuccio FP. Spatial analysis of risk factors for childhood morbidity in Nigeria. American Journal of Tropical Medicine and Hygiene. 2007;77(4):770–8.
92. Eshetu Gurmu, Akim Mturi. Trends and Determinants of Infant and Child Mortality in Ethiopia: Could the MDG four be met? Southern African Journal of Demography. 2014. 15(1):49-80
93. Cleland JG, van Ginneken JK. Maternal education and child survival in developing countries: The search for pathways of influence. Social science & medicine. 1988;27(12):1357-68.
94. Kisore S, Parasuraman S. *Mother's Employment and Infant and Child Mortality in India. Mumbai, India and Honolulu.* USA: NFHS Subject Report No8 IIPS and East-West Center, Program on Population. 1998.
95. Ruger JP, Kim HJ. Global health inequalities: an international comparison. Journal of epidemiology and community health. 2006;60(11):928-36.
96. MEXY KAKAZO, DEBORAH LEHMANN, KEITH COAKLEY, HELEN GRATTEN, GERARD SALEU, JOHN TAIME, et al. Mortality rates and the utilization of health services during terminal illness in the Asaro Valley, Eastern Highlands Province, Papua New Guinea. *P N G Med J* 1999; .42:13-29.
97. JOHN C. ANYANWU. ANDREW E. ERHIJAKPOR. Health Expenditures and Health Outcomes in Africa. African Development Bank. Economic Research Working Paper No 91 (December 2007).
98. *Cornelia Kaldewei*. Determinants of Infant and Under-Five Mortality - The Case of Jordan. *Technical note, February 2010*.
99. Ahamad MG, Tasnima K, Khaled N, Bairagi SK, Deb UK. Infant Mortality Situation in Bangladesh in 2007: A District Level Analysis [updated 2012/10/24/14:05:59]. Available from: http://mpra.ub.uni-muenchen.de/21102/ http://mpra.ub.uni-muenchen.de/21102/1/Infant_Mortality_Situation_in_Bangladesh_in_2007.pdf.
100. Macinko J, Guanais FC. Evaluation of the impact of the Family Health Program on infant mortality in Brazil, 1990-2002. Journal of Epidemiology and Community Health. 2006;60(1):13-9.
101. Malqvist M. Neonatal mortality: an invisible and marginalised trauma. Global health action. 2011;4:5724 - DOI: 10.3402/gha.v4i0.5724.
102. Raza S, Akhtar S, Avan B, Hamza H, Rahbar M. A matched case-control study of risk factors for neonatal tetanus in Karachi, Pakistan. Journal of Postgraduate Medicine. 2004;50:4.
103. Antai D. Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants. Population Health Metrics. 2011;9:6.
104. Berg C. Prenatal Care in Developing Countries. The World Health Organization Technical Working Group on Antenatal Care. Journal of the American Medical Women's Association. 1995;50(5):182-6.
105. Mayo-Wilson E, Imdad A, Herzer K, Yakoob MY, Bhutta ZA. Vitamin A supplements for preventing mortality, illness, and blindness in children aged under 5: systematic review and meta-analysis. BMJ : British Medical Journal. 2011;343:d5094, doi: 10.1136/bmj.d5094.
106. G. H. Beaton, R. Martorell, K. J. Aronson, B. Edmonston, G. McCabe, A. C. Ross a, et al. **E**ffectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries − Nutrition policy discussion paper No. 13. 1993.

107. Ramakrishnan U, Martorell R. The role of vitamin A in reducing child mortality and morbidity and improving growth. Salud Publica Mex. 1998 Mar-Apr;40(2):189-98.
108. Palloni A, Millman S. Effects of Inter-Birth Intervals and Breastfeeding on Infant and Early Childhood Mortality. . Population Studies. 1986;40(2):215-36.
109. Lantz Paula, Melissa Partin, Alberto Palloni. Using Retrospective Surveys for Estimating the effects of Breastfeeding and Childspacing on Infant and Child Mortality. Population Studies. 1992;46(1):121-39.
110. Safari JG, Kimambo SC, Lwelamira JE. Feeding practices and nutritional status of infants in Morogoro Municipality, Tanzania. Tanzania journal of health research. 2013;15(3):178-85.
111. Giashuddin MS, Kabir M, Rahman A, Hannan MA. Exclusive breastfeeding and nutritional status in Bangladesh. Indian journal of pediatrics. 2003;70(6):471-5.
112. Kumar D, Goel NK, Mittal PC, Misra P. Influence of infant-feeding practices on nutritional status of under-five children. Indian journal of pediatrics. 2006;73(5):417-21.
113. Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS. the Bellagio Child Survival Study Group. How many deaths can we prevent this year? *Lancet*. 2003;362:65–71.
114. World Health Organization. Global Strategy for Infant and Young Child Feeding. Geneva. 2003.
115. United Nations Children's Fund/World Health Organization. Baby friendly hospital initiative. Geneva, Switzerland: United Nations Children's Fund/World Health Organization. 2005.
116. Edmond KM, Zandoh C, Quigley MA, Amenga-Etego S, Owusu-Agyei S, Kirkwood BR. Delayed breastfeeding initiation increases risk of neonatal mortality. Pediatrics. 2006;117(3):e380-6.
117. Arifeen S, Black RE, Antelman G, Baqui A, Caulfield L, S. B. *Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums. . Pediatr* 2001;108(4):e67.
118. Betran AP, Onis M, Lauer JA, J. V. *Ecological study of effect of breast feeding on infant mortality in Latin America. . Br Med J*. 2001;***323***:***1-5***.
119. Yoon PW, Black RE, Moulton LH, S. B. Effect of not breastfeeding on the risk of diarrhea and respiratory mortality in children under 2 years of age in Metro Cebu, The Philippines. . *Amer J Epidemiol* 1996;143:***1142-8***.
120. Victora CG, Kirkwood BR, Ashworth A, al. e. Potential interventions for the prevention of childhood pneumonia in developing countries: Improving nutrition. *Am J Clin Nutr*. 1999;70:***309-20***.
121. Manda SOM. Birth intervals, breastfeeding and determinants of childhood mortality in Malawi. . *Social Science and Medicine* 1999;48(3):301-12
122. Van den Broeck J, Eeckels R, Massa G. Maternal determinants of child survival in a rural African community. International journal of epidemiology. 1996;25(5):998-1004.
123. World Health Organization. Essential Newborn Care. Report of a Technical Working Group (Trieste, 25-29 April 1994), Division of Reproductive Health (Technical Support), WHO, Geneva, Switzerland, . 1996.
124. Central Statistical Agency [Ethiopia]. Ethiopia Mini Demographic and Health Survey 2014. Addis Ababa, Ethiopia.
125. Penfold S, Hill Z, Mrisho M, Manzi F, Tanner M, Mshinda H, et al. A large cross-sectional community-based study of newborn care practices in southern Tanzania. PloS one. 2010;5:12.

126. Adelaja LM. A Survey of Home Delivery and Newborn Care Practices among Women in a Suburban Area of Western Nigeria. ISRN Obstetrics and Gynecology.2011:1-9.
127. Girma T, Nida H. TRADITIONAL NEWBORN CARE IN JIMMA TOWN, SOUTHWEST ETHIOPIA. Ethiop J Health Sci. , 2008. 18 (3): 79-86.
128. Jocelyn E Finlay, Emre Özaltin, David Canning. The association of maternal age with infant mortality, child anthropometric failure, diarrhoea and anaemia for first births: evidence from 55 low- and middle-income countries. BMJ Open 2011; 1:e000226
129. Fanciele Dinis Ribeiro, Rosângela Aparecida Pimenta Ferrari, Flávia Lopes Sant'Anna, José Carlos Dalmas, Edmarlon Girotto. Extremes of maternal age and child mortality: analysis between 2000 and 2009. Rev. paul. pediatr. 2014, 32(4). URL: http://dx.doi.org/10.1590/S0103-05822014000400015
130. Ettarh RR, Kimani J. Determinants of under-five mortality in rural and urban Kenya. Rural and remote health. 2012;12:1812.
131. Debelew GT, Afework MF, Yalew AW. Determinants and Causes of Neonatal Mortality in Jimma Zone, Southwest Ethiopia: A Multilevel Analysis of Prospective Follow Up Study. PLoS ONE. 2014, 9(9): e107184. doi:10.1371/journal.pone.0107184.
132. Kayode GA, Adekanmbi VT, Uthman OA. Risk factors and a predictive model for under-five mortality in Nigeria: evidence from Nigeria demographic and health survey. BMC Pregnancy and Childbirth. 2012;12:10.
133. Ronsmans C. Birth spacing and child survival in rural Senegal. International journal of epidemiology. 1996;25(5):989-97.
134. World Health Organization. Report of a WHO Technical Consultation on Birth Spacing. Geneva. 2006;June 2005.
135. Boerma JT, Bicego GT. Preceding birth intervals and child survival: searching for pathways of influence. Studies in family planning. 1992;23(4):243-56.
136. Howlader AA, Kabir M, MMU B. Healthseeking Behavior of Mothers and Factors Affecting Infant and Child Mortality. *Demography in India*. 2000;28(2):225-38.
137. Kaharuza F, Sabroe S, Scheutz F. Determinants of child mortality in a rural Ugandan community. East Afr Med J 2001;78(12):630-5.
138. Mirowsky J. and Ross C. E. Social Causes of Psychological Distress. Aldine de Gruyter, New York, 1989.
139. Hughes PM, Turton P, Evans CD. Stillbirth as a risk factor for depression and anxiety in the subsequent pregnancy: cohort study. *BMJ* 1999; 318: 1721–24.
140. Turton P, Hughes P, Evans CD, Fainman D. Incidence, correlates and predictors of post-traumatic stress disorder in the pregnancy after stillbirth. *Br J Psychiatry* 2001; 178**:** 556–60.
141. Poznanski EO. The "replacement child": a saga of unresolved parental grief. *J Paediatr* 1972; 81: 1190-93.
142. Hughes P, Turton P, Hopper E, McGauley GA, Fonagy P. Disorganised attachment behaviour among infants born subsequent to stillbirth. *J Child Psychol Psychiatry* 2001; 42: 791–801.
143. Bornstein, P. E., & Clayton, P. J. The anniversary reaction. *Diseases of the Nervous System, 1972, 33,* 470-472.
144. Parkes, C. M. The effects of bereavement on physical and mental health—A study of the medical records of widows. *British Medical Journal, 1964, 2,* 274-279.
145. Parkes, C. M., & Brown, R. Health after bereavement: A controlled study of young Boston widows and widowers. *Psychosomatic Medicine, 1972,* 34,449-461.

146. Parkes, C. M., & Weiss, R. S. *Recovery from bereavement.* New York: Basic Books. 1983.
147. Lehman,D.R.,Wortman,C. B.,&Williams, A. F. Long-term effects of losing a spouse or child in a motor vehicle crash. Journal of Personality and Social Psychology. 1987, 12(1): 218-231.
148. Lundin T. Long term outcome of bereavement. Br J Psychiatry. 1984;145:424–428.
149. Catherine H. Rogers, Frank J. Floyd, Marsha Mailick Seltzer, Jan Greenberg, Jinkuk Hong. Long-Term Effects of the Death of a Child on Parents' Adjustment in Midlife. Journal of Family Psychology. 2008;22(2):203–11.
150. Videka-Sherman, L., & Lieberman, M. A. The effects of self-help groups and psychotherapy after a child dies: The limits of recovery. *American Journal of Orthopsychiatry,* 1985, *55,* 70-82.
151. Jessop DJ, Riessman CK, Stein REK. Chronic childhood illness and maternal mental health. J Developmental Behav Pediatr. 1988;9:147–156.
152. D. Gary Benfield, Susan A. Leib, John H. Vollman. Grief Response of Parents to Neonatal Death and Parent Participation in Deciding Care. Pediatrics 1978;62:171-7.
153. J. O'Leary. Grief and its impact on prenatal attachment in the subsequent pregnancy. Arch Womens Ment Health. 2004;00:1–12.
154. Wheeler, I. Parental bereavement: The crisis of meaning. *Death Studies. 2001, 25,* 51-61.
155. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions: At Wereda Level from 2014 – 2017. 2013, Addis Ababa, Ethiopia
156. Karimollah Hajian. Sample size estimation in epidemiological studies. Caspian J Inten Med. 2011;2(4):289-98.
157. Fleiss J. L., Levin B., Paik M. C. Statistical Methods for Rates and Proportions, Third Edition, John Wiley and Sons, New York. 2003.
158. Regassa N. INFANT MORTALITY IN THE RURAL SIDAMA ZONE, SOUTHERN ETHIOPIA: EXAMINING THE CONTRIBUTION OF KEY PREGNANCY AND POSTNATAL HEALTH CARE SERVICES. Journal of Nursing, Social Studies, Public Health and Rehabilitation. 2012;1(2):51–61.
159. Mesganaw Fantahun, Yemane Berhane, Stig Wall, Peter Byass, Ulf Högberg. Women's involvement in household decision-making and strengthening social capital crucial factors for child survival in Ethiopia. Acta Paediatr. 2007 April 1; 96(4): 582–589.
160. Sileshi Garoma, Mesganaw Fantahun, Alemayehu Worku. Maternal Intimate Partner Violence Victimization and under-Five Children Mortality in Western Ethiopia: A Case-Control Study. JOURNAL OF TROPICAL PEDIATRICS. 2012, 58(6), 467-474.
161. Reinhard Kaiser, Bradley A. Woodruff, Oleg Bilukha , Paul B. Spiegel Peter Salama. Using design effects from previous cluster surveys to guide sample size calculation in emergency settings. Disasters, 2006, 30(2): 199−211.
162. Baumgartner JN, Parcesepe A, Mekuria YG, Abitew DB, Gebeyehu W, Okello F, et al. Maternal mental health in Amhara region, Ethiopia: a cross-sectional survey. Global health, science and practice. 2014;2(4):482-6.
163. Beusenberg M., Orley J. World Health Organisation; Geneva. A user's guide to the Self-Reporting Questionnaire (SRQ). 1994.

164. Alem A., Kebede D., Woldesemiat G., Jacobsson L., Kullgren G. The prevalence and socio-demographic correlates of mental distress in Butajira, Ethiopia. Acta Psychiatrica Scandinavica. Supplementum. 1999;397:48–55.
165. Vesile Senturk, Charlotte Hanlon, Girmay Medhin, Michael Dewey, Mesfin Araya, Atalay Alem, et al. Impact of perinatal somatic and common mental disorder symptoms on functioning in Ethiopian women: The P-MaMiE population-based cohort study. J Affect Disord. 2012;136 (3):340-9.
166. Tekalign Damena, Andualem Mossie, Markos Tesfaye. Khat Chewing and Mental Distress: A Community Based Study, in Jimma City, Southwestern Ethiopia. Ethiop J Health Sci. 2011;21(1):37-45.
167. Bizu Gelaye, Seblewengel Lemma, Negussie Deyassa, Yonas Bahretibeb, Markos Tesfaye, Yemane Berhane, et al. Prevalence and Correlates of Mental Distress Among Working Adults in Ethiopia. Clin Pract Epidemiol Ment Health. 2012;8:126-33.
168. Hanlon C., Medhin G., Alem A., Araya M., Abdulahi A., Hughes M., Tesfaye M., Wondimagegn D., Patel V., Prince M. Detecting perinatal common mental disorders in Ethiopia: validation of the self-reporting questionnaire and Edinburgh Postnatal Depression Scale. Journal of Affective Disorders. 2008;108:251–262.
169. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. International journal of epidemiology. 1997;26(1):224-7.
170. United Nations Statistics Division, Department of Economic and Social Affairs. Designing Household Survey Samples: Practical Guidelines. Series F No.98. New York, 2008. URL: http://unstats.un.org/unsd/demographic/sources/surveys/Series_F98en.pdf. Accessed on Sept 2015.
171. Lohr S.L. Sampling: Design and Analysis. Pacific Grove, CA: Brooks/Cole. 1999.
172. Agedew E, Chane T. Prevalence of Stunting among Children Aged 6–23 Months in Kemba Woreda, Southern Ethiopia: A Community Based Cross-Sectional Study. Advances in Public Health. 2015;2015:1-6.
173. Tafese B, Desalegn K, Tigist F, Tsehai A, Tadese F, Tesfaye H, et al. Effect of Nutrition Education on Feeding Practices and Nutritional Status of 6-23 Months Old Children at Demba Gofa and Geze Gofa Woredas, Gamo Gofa Zone, SNNPR. Research abstract presented on Ethiopian Public Health institution's research finding dissemination workshop. URL: http://www.ephi.gov.et/images/pictures/PPT_Tafese.pdf (Accessed on July 2 2015). .
174. Ngoc NT, Merialdi M, Abdel-Aleem H, Carroli G, Purwar M, Zavaleta N, et al. Causes of stillbirths and early neonatal deaths: data from 7993 pregnancies in six developing countries. Bull World Health Organ. 2006;84(9):699-705.
175. Allanson ER, Muller M, Pattinson RC. Causes of perinatal mortality and associated maternal complications in a South African province: challenges in predicting poor outcomes. BMC Pregnancy Childbirth. 2015;15:37.
176. Ersdal HL, Mduma E, Svensen E, Perlman J. Birth asphyxia: a major cause of early neonatal mortality in a Tanzanian rural hospital. Pediatrics. 2012;129(5):e1238-43.
177. Nattey C, Masanja H, Klipstein-Grobusch K. Relationship between household socio-economic status and under-five mortality in Rufiji DSS, Tanzania. Glob Health Action. 2013;6:19278.

178. Muhuri PK, Preston SH. Effects of Family Composition on Mortality Differentials by Sex Among Children in Matlab, Bangladesh. Population and Development Review. 1991, 17(3), 415-434.
179. Malwade BA. Is Discrimination in Food Really Necessary for Explaining Sex Differentials in Childhood Mortality? Population Studies. 1989, 43(2), 193-210.
180. Koenig MA, D'Souza S. Sex differences in childhood mortality in rural Bangladesh. Social Science & Medicine. 1986, 22(1), 15-22.
181. Sheth M, Obrah M. Diarrhea prevention through food safety education. Indian journal of pediatrics. 2004;71(10):879-82.
182. Mohan A, Nassir H, Niazi A. Does routine home visiting improve the return rate and outcome of DOTS patients who delay treatment? Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit. 2003;9(4):702-8.
183. Sankoh O, Byass P. Cause-specific mortality at INDEPTH Health and Demographic Surveillance System Sites in Africa and Asia: concluding synthesis. Glob Health Action. 2014;7:25590.
184. Streatfield PK, Khan WA, Bhuiya A, Hanifi SM, Alam N, Ouattara M, et al. Cause-specific childhood mortality in Africa and Asia: evidence from INDEPTH health and demographic surveillance system sites. Glob Health Action. 2014;7:25363.
185. Kyei KA. Determinants of Childhood Mortality in South Africa: Using Categorical Data Modeling. J Hum Ecol,. 2012;37(1):47-56.
186. Ezeh OK, Agho KE, Dibley MJ, Hall JJ, Page AN. Risk factors for postneonatal, infant, child and under-5 mortality in Nigeria: a pooled cross-sectional analysis. BMJ open. 2015;5(3):e006779.
187. Hossain M, Islam M. Effects Of Demographic And Household Variables On Infant And Child Under-five Mortality: An Application Of Logistic Model. The Internet Journal of Health. 2008, 8(2): 1-5.
188. World Health Organization. Indoor air pollution, health and the burden of diseas: Indoor air thematic breafing 2. URL: http://www.who.int/indoorair/info/briefing2.pdf. Accessed: September 3, 2015
189. Upadhyay AK, Singh A, Kumar K, Singh A. Impact of indoor air pollution from the use of solid fuels on the incidence of life threatening respiratory illnesses in children in India. BMC Public Health. 2015;15:300.
190. Islam MM, Azad KMAK. Rural-urban migration and child survival in urban Bangladesh: are the urban migrants and poor disadvantaged? Journal of biosocial science. 2008;40(1):83-96.
191. Fasil Tessema. Under five mortality and its predictors in Gilgel Gibe Health and Demographic Surveillance System Site, South West Ethiopia. Gilgel Gibe Field Research Center Institute of Health Sciences Research Jimma University (Unpublished reporet). 2008. http://www.intrec.info/Training%20material/Block%205/INTREC%20paper%20Fasil%20Tessema.pdf. accessed November 10, 2015.
192. Checkley W, Epstein LD, Gilman RH, Cabrera L, Black RE. Effects of acute diarrhea on linear growth in Peruvian children. American journal of epidemiology. 2003;157(2):166-75.
193. Lorntz B, Soares AM, Moore SR, Pinkerton R, Gansneder B, Bovbjerg VE, et al. Early childhood diarrhea predicts impaired school performance. The Pediatric infectious disease journal. 2006;25(6):513-20.

194. Alam N. Birth spacing and infant and early childhood mortality in a high fertility area of Bangladesh: age-dependent and interactive effects. Journal of biosocial science. 1995;27(4):393-404.
195. Kwakye K. O, Otupiri E., Dabo E. O., Browne E.N.L. Adjuik M. DETERMINANTS OF UNDER-FIVE MORTALITY IN BUILSA DISTRICT, UPPER EAST REGION, GHANA. Journal of Science and Technology, (2010), 30(1), 145-53.
196. Abir T, Agho KE, Page AN, Milton AH, Dibley MJ. Risk factors for under-5 mortality: evidence from Bangladesh Demographic and Health Survey, 2004-2011. BMJ open. 2015;5(8).
197. Alam N, Van Ginneken JK, Bosch AM. Infant mortality among twins and triplets in rural Bangladesh in 1975-2002. Tropical medicine & international health : TM & IH. 2007;12(12):1506-14.
198. Uthman OA, Uthman MB, Yahaya I. A population-based study of effect of multiple birth on infant mortality in Nigeria. BMC Pregnancy Childbirth. 2008;8:41.
199. Bahl R, Frost C, Kirkwood BR, Edmond K, Martines J, Bhandari N, et al. Infant feeding patterns and risks of death and hospitalization in the first half of infancy: multicentre cohort study. Bull World Health Organ. 2005;83(6):418-26.
200. Jakobsen MS, Sodemann M, Biai S, Nielsen J, Aaby P. Promotion of exclusive breastfeeding is not likely to be cost effective in West Africa. A randomized intervention study from Guinea-Bissau. Acta paediatrica (Oslo, Norway : 1992). 2008;97(1):68-75.
201. World Health Organization. MATERNAL, NEWBORN, CHILD AND ADOLESCENT HEALTH: approved by the WHO GUIDELINES REVIEW COMMITTEE: Recommendations on newborn health. http://www.who.int/maternal_child_adolescent/documents/guidelines-recommendations-newborn-health.pdf. Accessed: September 03, 2015.
202. World health organizations. Technical Consultation on Postpartum and Postnatal Care: Department of making pregnancy safer; Switzerland; World Health Organization;. 2008. http://apps.who.int/iris/bitstream/10665/70432/1/WHO_MPS_10.03_eng.pdf. Accessed: September 04,2015
203. World Health Organization. WHO recommendations on Postnatal care of the mother and newborn. 2013. http://apps.who.int/iris/bitstream/10665/97603/1/9789241506649_eng.pdf?ua=1. Accessed: September 04,2015.
204. Singh K, Brodish P, Haney E. Postnatal care by provider type and neonatal death in sub-Saharan Africa: a multilevel analysis. BMC Public Health. 2014;14:941.
205. Golam AM, Kaniz T, Nafisa K, Kanti BS, Kumar DU. Infant Mortality Situation in Bangladesh in 2007: A District Level Analysis. Centre for Policy Dialogue. 2010. URL: https://mpra.ub.uni-muenchen.de/21102/. Accessed on March 02, 2016.
206. World Health Organization. Vaccine-preventable diseases: monitoring system. 2016 global summary. Geneva, 2016. URL: http://apps.who.int/immunization_monitoring/globalsummary/schedules Accessed: February, 30, 2017.
207. Beaton GH, Martorell R, Aronson KJ, Edmonston B, McCabe G, Ross AC, et al. **E**ffectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries − Nutrition policy discussion paper No. 13. URL: http://wwwunscnorg/layout/modules/resources/files/Policy_paper_No_13pdf Accessed on Feb 20, 2016. 1993.

208. Joanna Ross, Charlotte Hanlon, Girmay Medhin, Atalay Alem, Fikru Tesfaye, Bogale Worku, et al. Perinatal mental distress and infant morbidity in Ethiopia: a cohort study. Arch Dis Child Fetal Neonatal Ed. 2011;96:59–64.
209. Medhin G, Hanlon C, Dewey M, Alem A, Tesfaye F, Lakew Z, et al. The effect of maternal common mental disorders on infant undernutrition in Butajira, Ethiopia: the P-MaMiE study. BMC psychiatry. 2010;10:32.
210. Boyle FM, Vance JC, Najman JM, Thearle MJ. The mental health impact of stillbirth, neonatal death or Sudden infant death syndrome(SIDS): prevalence and patterns of distress among mothers. *Soc. Sci. Med. 1*996; 43(8), 1273-1282.
211. Meert KL, Shear K, Newth CJ, Harrison R, Berger J, Zimmerman J, et al. Follow-up study of complicated grief among parents eighteen months after a child's death in the pediatric intensive care unit. Journal of palliative medicine. 2011;14(2):207-14.
212. Pollock JI, Manaseki-Holland S, Patel V. Depression in Mongolian women over the first 2 months after childbirth: prevalence and risk factors. J Affect Disord. 2009;116(1-2):126-33.
213. Chandran M, Tharyan P, Muliyil J, Abraham S. Post-partum depression in a cohort of women from a rural area of Tamil Nadu, India. Incidence and risk factors. The British journal of psychiatry : the journal of mental science. 2002;181:499-504.
214. Patel V, Kirkwood BR, Pednekar S, Weiss H, Mabey D. Risk factors for common mental disorders in women. Population-based longitudinal study. The British journal of psychiatry : the journal of mental science. 2006;189:547-55.
215. Evans DL, Charney DS, Lewis L, Golden RN, Gorman JM, Krishnan KR, et al. Mood disorders in the medically ill: scientific review and recommendations. Biological psychiatry. 2005;58(3):175-89.
216. Grimes DA, Schulz KF: Descriptive studies: what they can and cannot do. The Lancet 2002, 359(9301):145-149.

12.Appendices

12.1. Study instruments

PARTICIPANT'S INFORMATION SHEET

Title of the project: "Assessment of Magnitude and Determinants of Under-Five Mortality and Its Association with Maternal Mental Distress in Gamo Gofa Zone, Ethiopia"

Principal Investigator: Girma Temam (BSc, MPH)

Advisors: 1. Prof. Ahmed Ali (PhD, Prof.)
2. Prof. Alemayehu Worku (PhD, Prof)

Coordinating office: Addis Ababa University, School of Public Health

Introduction: Although there is documented reduction in child mortality and indication of the achievement of the MDG4 by the country (Ethiopia), mortalities are still high compared to other countries. Besides, it is clear that efforts should be continued to sustain the reduction of mortalities beyond MDGs. The death of a child is one of the most stressful events that a person can experience during the course of his or her life and may have sustained mental health effect on the families particularly on the mother. Studies investigating the determinant factors of child mortality and post child loss maternal mental health in developing countries particularly in Ethiopia are rare. Those few are either context insensitive and cross-sectional in design. The findings are also inconsistent. This warrants the need for investigating determinant factors of child mortality and its effect on maternal mental wellbeing to design possible interventions gearing to the specific age group and context/community.

Purpose: The Objective of this research is to assess the magnitude and correlates of under-five mortality and its association with maternal mental health in Gamo Gofa Zone, Southern Ethiopia.

Procedure and Participation: The method of the research involves descriptive and comparative cross sectional and case control observational studies. The expected duration of the participant's contact with the interviewer will be not more than thirty minutes. You will be asked to participate in this research because the trustful information which you will provide is important for the understanding of the proposed subject matter. Moreover, your particular participation is affirmed

by the sampling frame through the procedure of probability sampling technique which provides equal chance of selection. You will be asked about your socio-demography, reproductive history, child feeding and newborn care practices and other related questions that are very important for the fulfillment of the research.

Confidentiality: to establish secured safeguards of the confidentiality of research data, the PI will use codes during data processing instead of using names. The original data will be locked in cabinets until the data analysis is carryout and no person shall access except the PI and the advisors for data checking and cleaning purpose. The use of information for any purpose other than that to which participants consented is unethical to the participants. The information you provide is not disclosed in the way it id entifies your personal characteristics and privacy. After the research defense and final work is approved by the School of Public Health and the Academic Commission and the University's Senate, the original data questionnaire will be incinerated in secure manner.

Benefit: The research does not have a short term financial, health care and capacity building benefit to the research participant as an individual or as a group, but in the long run it will help the concerned organizations and policy makers to have a policy consideration and direction and formulation of strategy and design of child and maternal mental health programs based on the recommendations and the findings. Moreover the research work will help as a base line data in the field.

Risk: The proposed research does not have any inhumane treatment of research participants and any physical harm, social discrimination, psychological trauma and economic loss.

Inducement, incentive and Compensation: This study process has not any form of inducement, coercion and the study does not bring any risks that incur compensation.

Results Dissemination: The researchers are responsible for dissemination of findings and fully accountable to provide feedback to the concerned health departments in the area. The findings will be presented at School of Public Health, Addis Ababa University. Effort will be done to publish the findings in scientific reputable journal.

Freedom to withdraw: If you don't want to participate in the study, you have full right to withdraw from the study any time you wish. This would have no effect at all on your health benefit

or other administrative effect that you get from health facilities and nobody will enforce you to explain the reason for withdrawal.

Person to Contact: The participant has the right to ask information that is not clear about the research context and content before and or during the research undertaking. You can contact the principal investigator and his advisors. Moreover, this research has undergone ethical review and approved by the Addis Ababa University, College of Health Sciences IRB. The main task of this board is to make sure that the ethical principles are adhered to or not and the research participants are protected from harm.

If you want more information and check about this project you can contact the following people
Addis Ababa University College of Health Sciences IRB Secretary Office Tel. 0115512876
Principal Investigator:

Girma Temam,
Arba Minch University
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Supervisors: 1. Prof Ahmed Ali (PhD, Prof.), mob. 0911684399
2. Prof. Alemayehu Worku (PhD, Prof), mob. 0911405652

School of Public Health, College of Health Sciences, Addis Ababa University

Consent Form

My name is _____. I am working with a research team from the Addis Ababa University. We are interviewing systematically selected women/care givers of children about determinants of child mortality and related issues. The purpose of the study is to assess the extent and determinants of childhood mortality and its association with maternal mental distress, which is expected to be helpful to design, plan and implement programs aiming to reduce childhood mortality and maternal mental illnesses. I am going to ask you certain questions that are very important for the fulfillment of the research. Your answers are completely confidential. Your name or other identifications will never be used in connection with any of the information you tell me. You do not have to answer any question that you do not want to answer, and you may end this interview at any time you want. However, your honest answers to these questions will help to fulfill the study and to provide information to the programmers to design, plan and implement appropriate interventions. We would greatly appreciate your help in responding to this survey.

A. Are the information/ objectives clear?

1. Yes 2. No ⟶ explain again

B. Would you be willing to participate?

1. Yes ⟶ continue the interview
2. No ⟶ Stop and go to the next HH

Thank you

C. Interviewer's signature certifying that, the informed consent has been given by the respondent

Name_____ Signature _____ Date_____

Data Collection Form for House to House Census

District___________________ Kebele___________________Gote________________________Block No.____________________Name of group (development army) ________________________

S.No.	Gote	House No.	Name of Head of House Hold	Children under 7 years of age in the house Hold (who born between Sept 01, 2007 and Sept 30, 2014)										
				Name of the child (start from the youngest)	Child ID	Sex (M or F)	Age (in month)	Date of **birth** (dd/mm/yy)	Dead/ alive 1.alive 2.dead	**If dead**				
										Age of the child at death (in month)	Date of **death** (dd/mm/yy)	Does the child died on date of birth 1.yes 2.No	If died on date of birth, is s/he died immediately after birth? 1.Yes 2.No	If died immediately after birth, does s/he born dead? 1.Yes 2.No
				1.				__/__/_____			__/__/_____			
				2.				__/__/_____			__/__/_____			
				3.				__/__/_____			__/__/_____			
				1.				__/__/_____			__/__/_____			
				2.				__/__/_____			__/__/_____			
				3.				__/__/_____			__/__/_____			
				1.				__/__/_____			__/__/_____			
				2.				__/__/_____			__/__/_____			
				3.				__/__/_____			__/__/_____			
				1.				__/__/_____			__/__/_____			
				2.				__/__/_____			__/__/_____			
				3.				__/__/_____			__/__/_____			

Name of data Collector ____________________________Sig& Date_________________________

Name of Supervisor _____________________________Sig& date_________________________

Data Collection Form for House to House Census ………

District_____ Kebele_____Gote_____Block No._____Name of group (development army) _____

S.No.	Child ID	Name of the mother	Age of the mother	Does the mother live with the child? 1.Yes 2.No	Is the mother alive or dead? 1.Alive 2.Dead	Marital status of the mother 1.Married 2.Single 3.Divorced 4.Widowed 5. Separated	Remark
1.							
2.							
3.							
1.							
2.							
3.							
1.							
2.							
3.							
1.							
2.							
3.							

Name of data Collector _____Sig& Date_____

Name of Supervisor _____Sig& date_____

Kebele level information collected

District _____ Kebele _____

S.No.	Indicators	Coding/ classification	Remark
1.	Residence	1. Urban 2. Rural	
2.	Climatic and geographic location	1. Dega 2. Woina dega 3. Kolla 4. Other (specify)_____	
3.	Does the kebele has all weather road?	1. Yes 2. No	
4.	Distance from Arba minch Hospital (in km and walking distance)	_____km _____hr	
5.	Distance from nearby health center	_____km _____hr	
6.	Presence of private health facilities (clinics, drug vendors)	1. Yes 2. No	
7.	If yes type of health facility?	1. Clinic 2. Pharmacy/drug vendor 3. Other (Specify)_____	
8.	Main livelihood of the community?	1. Farming of cash crops (banana, mango) 2. Farming of stable food 3. Trading 4. Other (Specify)_____	
9.	Common staple foods of the community?	1. Maize 2. Teff 3. Enset 4. Other (Specify)_____	
10.	Maternal health service coverage	ANC_____% Family planning_____% Post natal care_____% Professional assisted delivery_____%	2006 E.C. (2013/14)
11.	Child health service coverage	EPI coverage_____% Vit A coverage_____% Bed net coverage_____% Maternal TT vaccine coverage _____%	2006 E.C. (2013/14)
12.	Presence of secondary school in the kebele	1. Yes 2. No	
13.	Presence of elementary school in the kebele	3. Yes 4. No	
14.	Latrine coverage rate in the kebele	_____%	2006 E.C. (2013/14)
15.	Presence of safe water supply in the kebele	1. Yes 2. No	2006 E.C. (2013/14)
16.	Is the kebele malarious or not	1. Yes 2. No	
17.	Number of household of the kebele?	_____	
18.	Number/percent of model households graduated in the kebele	_____number _____/%	2006 E.C. (2013/14)
19.	Do the HEWs have delivery kit and providing delivery service in the health post?	1. Yes 2. No	

20.	How many trained traditional birth attendants working in the kebele?	_____	
21.	How many health extension workers are working in the kebele?	_____	
22.	Perceived political commitments by the administration of the kebele towards Health extension programs (according to HEWs)	1. Very good 2. Good 3. Fair 4. Poor 5. Very poor	
23.	Competencies and commitment of health extension workers in the kebele (according to the kebele administrator)	1. Very good 2. Good 3. Fair 4. Poor 5. Very poor	

English Version of the Main Questionnaire

District_____ Kebele_____ Gote_____
House number_____Child ID_____Mother ID_____

Survey questionnaire to determine determinants of childhood mortality and its association with maternal mental distress in Gamo Gofa Zone, Southern Ethiopia

My name is _____. I am working with a research team from Addis Ababa University. We are interviewing systematically selected women/care givers of children about determinants of child mortality and related issues. The purpose of the study is to assess the extent and determinants of child mortality and its association with maternal mental distress, which is expected to be helpful to design, plan and implement programs aiming to reduce child mortality and maternal mental illnesses. I am going to ask you some questions that are very important for the fulfillment of the research. Your answers are completely confidential. Your name or other identifications will never be used in connection with any of the information you tell me. You do not have to answer any question that you do not want to answer, and you may end this interview at any time you want to. However, your honest answers to these questions will help to fulfill the study and to provide information to the programmers to design, plan and implement appropriate interventions. We would greatly appreciate your help in responding to this survey.

D. Are the information/ objectives clear?
1. Yes 2. No ⟶ explain again

E. Would you be willing to participate?
3. Yes ⟶ continue the interview
4. No ⟶ stop and go to the next HH
Thank you

F. Interviewer's signature certifying that, the informed consent has been given by the respondent
Name_____ Signature _____ Date_____

G. Result of the questionnaire
1. Completed 2. Refused 3. Partially completed 4. Other_____

H. Type of participant
1. Child dead 2. Child alive

Part I: Socio-Economic and Demographic characteristics

No	Questions	Coding/ classifications	Skip to	Remark
101	Sex of the respondent	Male……1 Female……2		
102	Age of the respondent	_____years		
103	What is your relationship to the child?	Mother…….....1 → 106 Father……..……2 Brother/sister……..…….…3 Grandparent……..…4 Other relative (specify) _____ 5		
104	If the answer to Q103 is not 1, does the mother of the child alive?	Alive……1 → 106 Died ……2 Don't know……...…….99 → 106		
105	If the mother died, when was she died? (more than 1 response is possible)	During labor…….1 Immediately after birth……..…2 With in two months of birth…….3 After two months of birth……4 After the child was died……...5		
106	What is the sex of the child?	Male……1 Female……2		
107	When was the child born?	DD/MM/YYYY_____/_____/_____		
108	What was the age of the mother at the time the baby born?	_____years Don't know …… 99		
109	What was the mother's religion when the child was born?	Protestant ……1 Orthodox ……..2 Muslim……..3 Catholic…….....4 Others (specify)_____5		
110	What is the current religion of the mother?	Protestant ……1 Orthodox ……..2 Muslim……..3 Catholic…….....4 Others (specify)_____5		
111	To which ethnic group the mother belongs to?	Gamo.....1 Gofa.....2 Wolayita.....3 Zeise .....4 Amhara .....5 Ganjule.....6 Other (specify)……7		
112	What was the mother's completed educational status when the child was born?	Illiterate……1 Read and write ……2 Grade 1 to 6 ……3 Grade 7 to 8 ……4 Grade 9 to 12 ……5 Above grade 12……6		
113	What is the mother's current completed educational status?	Illiterate……1 Read and write ……2		

		Grade 1 to 6 ……3 Grade 7 to 8 ……4 Grade 9 to 12 ……5 Above grade 12……6		
114	What was the mother's occupation when the child was born?	Farmer……...1 House wife ……....2 Government employee……3 Merchant……4 Jobless ……5 Housemaid ……6 Student ……7 Others (Specify)_____8		
115	What is the mother's current occupation?	Farmer……...1 House wife ……....2 Government employee……3 Merchant……4 Jobless ……5 Housemaid ……6 Student ……7 Others (Specify)_____8		
116	What was the mother's marital status when the child was born?	Married……1 Single……2→120 Divorced……..3→120 Widowed……4→120 Separated……5→120		
117	If married to Q116, how many wives did the husband has including the mother, when the child was born?	The mother only……1 Two……...……2 Three ……...…….3 Four or more……4		
118	What was the husband's occupation when the child was born?	Farmer……...1 Government employee……..……2 Merchant……...…….3 Jobless ……...……4 Housemaid ……...…….5 Student ……..……6 Others (Specify)_____7		
119	What was the husband's educational status when the child was born?	Illiterate……1 Read and write ……2 Grade 1 to 6 ……3 Grade 7 to 8 ……4 Grade 9 to 12 ……5 Above grade 12……6		
120	What is the mother's current marital status?	Married……1 Single……2→124 Divorced……..3→124 Widowed……4→124 Separated……5→124		
121	If married to Q120, currently how many wives does the husband have including the mother?	The mother only……1 Two……...……2 Three ……...…….3		

		Four or more……4		
122	What is husband's current occupation?	Farmer……...1 Government employee……..……2 Merchant……..……3 Jobless ……..……4 Housemaid ……..……5 Student ……..……6 Others (Specify)_____7		
123	What is the husband's current educational status?	Illiterate……1 Read and write ……2 Grade 1 to 6 ……3 Grade 7 to 8 ……4 Grade 9 to 12 ……5 Above grade 12……6		
124	What was the main source of income of the family when the child was born?	Labor ……1 Farming of cash crops……..……2 Other(specify)_____3		
125	What is the main source of income of the family now?	Labor ……1 Farming of cash crops……..……2 Other(specify)_____3		
126	What was the family's monthly income, when the child was born?	_____Birr per month No income ……1 No response……98		
127	What is the family's monthly income now?	_____Birr per month No income ……1 No response……98		
128	If you compare the monthly income of the family with the neighbors, where do you put the economic status of the family when the child was born?	Very poor……..1 Poor……..2 Medium……3 Rich……...……4 I can't say…….……5 No response……...……..98		
129	If you compare the current monthly income of the family with the neighbors, where do you put the economic status of the family?	Very poor……..1 Poor……..2 Medium……3 Rich……...……4 I can't say…….……5 No response……..……..98		

Part II: Housing condition

201	How many family members were living in the house when the child was born?	_____number		
202	Currently, how many family members are living in the house?	_____number		
203	What was the roof of the house made of, when the child was born?	Corrugated iron……1 Thatched……2 Other(specify_____3		
204	Currently, what is the roof of the house made of?	Corrugated iron……1 Thatched……2 Other(specify_____3		

205	Who was the owner of the house when the child was born?	Personal……1 Rental……2 Others, specify_____3		
206	Currently the owner of the house is?	Personal……1 Rental……2 Others, specify_____3		
207	How many rooms did the house have, when the child was born?	_____number		
208	How many rooms does your house have now?	_____number		
209	Did the house have a window when the child was born?	Yes……..…….1 No……..….2		
210	Does the house have a window now?	Yes……..……...….1 No……...2		
211	Did animals live with humans in the same housing unit when the child was born?	Yes……..…….1 No……..….2		
212	Do animals live with humans in the same housing unit now?	Yes……..…….1 No……..….2		
213	Was the cooking usually done in the house, in a separate building, or outdoors when the child was born?	In the house……..…1 In a separate building……..…..2 Outdoors……..…...3 Other (specify)_____4		
214	Did the house have a separate kitchen when the child was born?	Yes……..…….1 No……..….2		
215	Is the cooking usually done in the house, in a separate building, or outdoors now?	In the house……..…1 In a separate building……..…..2 Outdoors……..…...3 Other (specify)_____4		
216	Does the house have a separate kitchen now?	Yes……..…….1 No……..….2		
217	Did the household have the followings, when the child was born?	YES NO Electricity? 1 2 A radio? 1 2 A television? 1 2 A mobile telephone? 1 2 A non-mobile telephone? 1 2 A refrigerator 1 2		
218	Does the household currently have: Electricity? A radio? A television? A mobile telephone? A non-mobile telephone? A refrigerator?	YES NO Electricity? 1 2 A radio? 1 2 A television? 1 2 A mobile telephone? 1 2 A non-mobile telephone? 1 2 A refrigerator 1 2		
219	What was the major source of lighting facility for the house when the child was born?	Electricity……..……1 Fanos……2 Kerosene lamp……..……...3 Other (specify)_____4		

220	What is the major source of lighting facility for the house now?	Electricity……1 Fanos……2 Kerosene lamp……3 Other (specify)_____4		
221	What was the major source of fuel for cooking food in the house, when the child was born?	Wood ……..1 Anima dung……2 Charcoal……..3 Kerosene……4 Electricity……5 Others, specify_____6		
222	What is the major source of fuel for cooking food in your house now?	Wood ……..1 Anima dung……2 Charcoal……..3 Kerosene……4 Electricity……5 Others, specify_____6		
223	Did any member of your household own any of the followings when the child was born?	Yes/No if yes, number Bicycle _____ _____ Motorcycle _____ _____ Car _____ _____ Livestock _____ _____ Pack animals _____ _____ Sheep/goats _____ _____ Chicken (poultry) _____ _____		
224	Does any member of your household currently own: Bicycle? Motorcycle? Car? Livestock? Pack animals? Sheep/goats? Chicken (poultry)?	Yes/No if yes, number Bicycle _____ _____ Motorcycle _____ _____ Car _____ _____ Livestock _____ _____ Pack animals _____ _____ Sheep/goats _____ _____ Chicken (poultry) _____ _____		

Part III: Water and sanitation

301	What was the source of drinking water for your family when the child was born?	Tap……...1 Protected well/ spring……..…2 Unprotected well/spring ……..…3 River/pond……..…..4 Other (specify)_____5		
302	Did you do anything to the water to make it safer to drink, when the child was born?	Yes……..……..…….1 No……..….2 →	304	
303	If yes to Q302, how?	Boiling……..……1 Chemicals……2 Sand filter……3 Others, specify_____4		
304	Current source of drinking water of the family is?	Tap……..…1 Protected well/ spring……..…2 Unprotected well/spring ……..…3 River/pond……...4 Other (specify)_____5		

305	Do you do anything to the water to make it safer to drink now?	Yes……..……..…….1 No……..….2 →	307	
306	If yes to Q305, how?	Boiling ……1 Chemicals……2 Sand filter……3 Others, specify_____4		
307	Did the family have latrine facility when the child was born?	Yes……..……..….1 No…….2 →	310	
308	If yes, What was the type of the latrine?	Simple Pit……1 VIP……..2 Flush toilet……..3 Other (specify)_____4		
309	Was the latrine shared with other households or not?	Shared……..1 Not shared……2 Other (specify)_____3		
310	Does the family have latrine facility now?	Yes……..……..…….1 No…….2 →	401	
311	If yes, What is the type of the latrine?	Simple Pit…….……1 VIP…….……..2 Flush toilet…….……..3 Other (specify)_____4		
312	Is the latrine shared with other households or not	Shared……..1 Not shared……2 Other (specify)_____3		
313	Cleanliness of the latrine (Observe)	Clean……1 Not clean ……2		

Part IV: Reproductive History of the mother

401	Had ever the mother been pregnant prior to the pregnancy of the index child?	Yes……..……..…….1 No……..2 →	413	
402	If yes, how many pregnancies the mother had before the index child?	_____Number		
403	How many of these pregnancies ended up with: Abortion? Still birth? Live birth?	Number Abortion_____ Still birth_____ Live birth_____ Don't know_____		
404	What was the outcome of the pregnancy just prior to the index child?	Abortion……..….1 Still birth……..…..2 Live birth……..….3 Don't know…….99		
405	What is the interval between the termination of the preceding pregnancy and the birth of index child?	_____months		
406	What is the interval between the termination of the preceding pregnancy and the pregnancy of the index child?	_____months		
407	If not live birth to Q404, What is the interval between the preceding live birth and the index birth?	_____months		

408	If live birth to Q404, was this child dead or alive?	Alive……..…..….1 Dead……..…..…..2 Don't know…….99		
409	Did there any child who is older than this child died?	Yes……..……...1 No……..….2 →	411	
410	If yes to Q409. How many died?	_____number		
411	What is the birth order of the index child?	First ……..……1 → Second ……..….2 Third …….....3 Fourth or higher ……4 Don't know …….....99	413	
412	If the birth order of the child is more than one, how many alive children were the mother has when the child was born?	_____number		
413	Does any child born after the index child?	Yes……..……...….1 No……..…….2 →	418	
414	If yes to Q413. How many?	_____number		
415	After how many months of the birth of the index child, the child next to the index child born?	_____months		
416	Is there any child who is younger than this child died?	Yes……..…….1 No……...……2 →	418	
417	If yes to Q416. How many died?	_____number		
418	How many children does the mother have now?	_____number		
419	Are you pregnant now?	Yes ……..……... 1 No …….…… 2 → Unsure…….3 →	501 501	
420	How many months pregnant are you now?	_____months		

Part V: Maternal and child health service utilization

501	Did the mother receive antenatal care for the pregnancy of the index child?	Yes ……..……...1 No ……..……2 → Don't know ……..99 →	506 506	
502	Where was the ANC service obtained?	Hospital…….…....1 Health Center……2 Health Post……..…..…….3 Other (specify)….. ….. ……..4 Don't know ……..99		
503	When was the first ANC checkup made during the pregnancy?	Within the first 3 months……..……1 Within the 1st 6 months……..2 After 6th months of pregnancy……..…..3 Don't know……..99		
504	How many times the mother received antenatal care during the index pregnancy?	_____Number Don't know……99		

505	Who provided the ANC service?	Doctor /HO……..…....1 Nurse/midwife…….…....2 HEW……...…3 Trained TBA……..…4 Traditional birth attendant……..…..... 5 Other (specify)_____9 Don't know ……..…….99		
506	Did the mother received tetanus toxoid (TT) vaccine?	Yes ……....1 No ……..….2 → 508 Don't know……...99 → 508		
507	Which dose of TT she had taken? (from card or history)	TT1…….…....1 TT2…….…....2 TT3…….…....3 TT4…….…....4 TT5…….…....5 Don't know …… 99		
508	Where was the child born?	Home …….…....1 Hospital……..…..…2 Health Center……3 Health Post……..…….……4 Other health facility …... ……..…..5 Other (specify)_____7 Don't know ……..….....99		
509	Who assisted with the delivery?	Health worker…… 1 Health Extension Worker …….. 2 Trained TBA……..…3 Traditional birth attendant …… 4 Relative……...…..5 Neighbor……..……6 Mother by herself …….……...…..7 Other_____8 Don't know……99		
510	Was the child a single or multiple birth?	Singleton……..……..…1 Twin ……..2 Triplet or more ……..3 Don't know ……...99		
511	When the child was born, was he/she very large, larger than average, average, smaller than average, or very small?	very large……1 larger than average……..……2 average……..…….…3 smaller than average……..……4 very small……..……..5 Don't know ……...99		
512	Did the mother's and/or the child's health checked by health professional after birth of the index child?	Yes……..…..1 No……..……..2 → 517		
513	If yes, who checked her own and/or her child's health status?	Health worker…… 1 Health Extension Worker …….. 2 Trained TBA……..…3 Traditional birth attendant …… 4 Relative……...…..5		

		Neighbor……..……6 Mother by herself …….……...…..7 Other_____8 Don't know……99		
514	Where was the checkup made?	Hospital…….....1 Health Center……..…..…2 Health Post……..……3 Home……..……..……4 Other (specify_____5 Don't know ……..99		
515	How long after delivery did the first check take place?	_____Hours _____days _____weeks		
516	How many times such checkup was made before 42 weeks of birth?	Once……..1 At two occasions……...…….2 At three occasions……..…3 More than three occasions……..4 Don't know ……99		
517	Did the index child get vaccination	Yes……...1 No……..……2 →	520	
518	If yes to Q517, which vaccines the child has taken so far? (from card or history)	Yes No Polio0 _____ _____ BCG _____ _____ Polio1 _____ _____ Polio2 _____ _____ Polio3 _____ _____ Penta1 _____ _____ Penta2 _____ _____ Penta3 _____ _____ Measles _____ _____		
519	If yes to Q517, what is/was the immunization status of the child? (from card or history)	Fully vaccinated……..……1 Partially vaccinated……..……2 Not vaccinated at all……3 Don't know……99		
520	Did the index child receive a vitamin A like this? (from card or history)	Yes……...…..1 No…….2 → Don't know…….99 →	522 522	
521	If yes to Q520. How many times?	_____number		
522	Please tell me at which of the following places or facilities usually the family seek treatment when the child get sick.	YES NO DK Home …….. 1 2 8 Traditional healer…….. ……. 1 2 8 Government Health Post.……...1 2 8 Government Health center…....1 2 8 Government hospital ……..…1 2 8 Private clinic …..……...1 2 8 Private hospital…… 1 2 8 Pharmacy, drug seller, store….1 2 8 Other(Specify)_____		

523	Did the mother have history of chronic medical illness during the pregnancy of the index child?	Yes……..1 No……..….2 →	525	
524	If yes, what were the problems? (multiple responses are possible)	Diabetes mellitus ……..…....1 Cardiac Disease…… 2 Hypertension ……..3 Renal Disease ……4 Other(Specify) _____5		

Part VI. Child feeding and new born care practice

601	Was the child ever breastfeed?	Yes……...1 No…….....2 →	604	
602	How long after birth did the child put to the breast?	_____hrs _____days		
603	How long did the child breast feed?	Still breast feeding _____months		
604	In the first three days after delivery, was the child given anything other than breast milk?	Yes……..1 No……...….2 → No response……..……98 →	606 606	
605	If yes to Q604, what was given?	Milk (other than breast milk) . . …..……1 Plain water . . . . . ……....2 Sugar-salt-water solution . . . . . ……3 Fruit juice . . . . . ……..……4 Infant formula . . . . ……..……..5 Honey . . . . . ……..……..6 Fresh butter . . . . . ……7 Other (specify)_____8		
606	In the first 6months after delivery, was the child given anything to drink and/or eat other than breast milk?	Yes……..1 No……...….2 → No response……..……98 →	609 609	
607	What was given to drink and/ or eat in the first 6 months?	Plain water . . . . . ……..……..1 Milk (other than breast milk) . . . …….. ….2 Gruel…… . . . . ……...……3 Fresh butter . . . . . ……..……4 Sugar-salt-water solution . . ... ……5 Fruit juice . . . . . ……..…6 Infant formula . . . . ……..7 Tea/infusions . . . . . ……..……..……8 Honey . . . . . ……..9 Adult foods……10 Other (specify)_____11		
608	After how long after birth, it was started?	_____days _____months		
609	Did the child drink anything from a bottle with a nipple?	Yes……..……...…..1 No……..…...….2 No response……...……98		
610	If the child is older than 6months, did the child have been given additional food other than breast milk?	Yes……...……..1 No……..……2 → No response……...……98 →	613 613	

611	When was additional food started after birth?	_____days _____months		
612	What was the additional food give to the child	Cow milk……1 Gruel……..2 Adult foods……..……3 Other(specify)_____4		
613	When was the child given first bath after birth?	Immediately after delivery……..1 After an hour of delivery…….2 After 6 hours……3 After 12 hours……4 After 24 hours……5 After 48 hours……6		
614	Was there anything applied at the umbilical wound of the child after birth?	Yes……..1 No……..….2 → 616 No response……..…….98 → 116		
615	If yes to Q614, what was applied?	Butter……....…1 Animal dung…….……..…2 Other (specify)_____3		
616	Did the child ever get sick?	Yes……..1 No……..….2 → 619 No response……..…….98 → 619		
617	If yes, did s/he have any treatment?	Yes……..1 No……..….2 → 619 No response……..…….98 → 619		
618	Where did s/he get the treatment	Home…….……1 Traditional healer…….2 Health Post ……..……3 Health Center……..…….4 Hospital…….……..5 Private clinic……..…..……..6 Private pharmacy…….7 Others(specify)……8		
619	Were the followings done for the child after birth?	Yes No Uvulectomy 1 2 Milk teeth extraction 1 2 Skin piercing/burning 1 2 Other(specify)_____		

Part VII: Woman's status

701	Did the mother earn any sort of cash either by working or selling house goods, when the child was born?	Yes……..1 No……..….2 → 703 No response……..…….98 → 703		
702	Who usually did decide how the money she earns will be used when the child was born?	The mother……1 Her husband/partner…….2 She and her husband/partner jointly……3 Other (specify)_____4		
703	Does the mother earn any sort of cash either by working or selling house goods now?	Yes……..1 No……..….2 → 705 No response……..…….98 → 705		

704	Who usually decides how the money she earns will be used now?	The mother……1 Her husband/partner……2 She and her husband/partner jointly……3 Other (specify)_____4		
705	Who usually did decide how the husband's earnings will be used when the child was born?	The mother……..……1 Her husband/partner……..……..2 She and her husband/partner jointly…….3 The husband has no earnings……4 Other (specify)_____5		
706	Who usually decides how the husband's earnings will be used now?	The mother……1 Her husband/partner……2 She and her husband/partner jointly……3 The husband has no earnings……4 Other (specify)_____5		
707	Who usually made decisions about health care for the mother when the child was born?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
708	Who usually makes decisions about health care for the mother now?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
709	Who usually made decisions about making major household purchases when the child was born?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
710	Who usually makes decisions about making major household purchases now?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
711	Who usually made decisions about visits to her family or relatives when the child was born?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
712	Who usually makes decisions about visits to her family or relatives now?	The mother……..……1 Her husband/partner……2 She and her husband/partner jointly……3 Someone else……4 Other (specify)_____5		
713	Did the husband help the mother with household chores like looking after the children, cooking, cleaning the house, and doing other work around the house when the child was born?	Yes……..……..1 No……2 No response……..……98		

714	Does the husband help the mother with household chores like looking after the children, cooking, cleaning the house, and doing other work around the house now?	Yes……..……..1 No…….2 No response……..…….98		
715	In your opinion, is a husband justified in hitting or beating his wife in the following situations: If she goes out without telling him? If she neglects the children? If she argues with him? If she refuses to have sex with him? If she burns the food?	Yes No DK Goes out . . . .…..1 2 8 Negl. Children. . …… 1 2 8 argues . . . .…..1 2 8 Refuses sex . . . . . …….. 1 2 8 Burns food . . . .….. 1 2 8		
716	Was your opinion different from the above (Q715), when the child was born?	Yes……..……..……...1 No…….2 →	718	
717	If yes to Q716, in which acts?	Yes No DK Goes out . . . .…..1 2 8 Negl. Children. . …… 1 2 8 Argues . . . .…..1 2 8 Refuses sex . . . . . …….. 1 2 8 Burns food . . . .….. 1 2 8		
718	Had the mother ever been beaten by her husband when the child was born?	Yes……..……..1 No…….2 No response……..…….98		
719	Has the mother ever been beaten by her husband now?	Yes……..……..1 No…….2 No response……..…….98		
720	Is there a law in Ethiopia that prevents a husband from beating his wife?	Yes……..……...…..1 No……...….2 Don't know…..……..…….99		

I have finished my questions.
Thank you very much.

Checked by supervisor: Name_____ Signature _____ Date_____

World Health Organization's Self Reporting Questionnaire (SRQ-20)

District_____ Kebele_____ Gote_____

House number_____Child ID_____Mother ID_____

Instruction for the interviewer to fill the SRQ-20:

Please read the entire introduction before you fill in the questionnaire. It is very important that everyone interviewing the respondents/ filling the questionnaire follows the same instruction.

Introduction

The following questions are related to certain pains and problems that may have bothered you the **last 30 days**. If you think the question applies to you and you had the described problem in the **last 30 days**, answer **YES**.

On the other hand, if the question doesn't apply to you and **you did not have** the problem in the **last 30 days**, answer **NO**.

Please do not discuss the questions with anyone while answering the questionnaire.
If you are unsure about how to answer a question, please give the best answer you can.
We would like to reassure you again that the answers you are going to provide here are **confidential**.

Do you have any question or concern?

World Health Organization's Self Reporting Questionnaire (SRQ-20)

S. No.	Questions	Response	
1.	Do you often have headache?	1. Yes	2. No
2.	Is your appetite poor?	1. Yes	2. No
3.	Do you sleep badly?	1. Yes	2. No
4.	Are you easily frightened?	1. Yes	2. No
5.	Do your hands shake?	1. Yes	2. No
6.	Do you feel nervous, tense or worried?	1. Yes	2. No
7.	Is your digestion poor?	1. Yes	2. No
8.	Do you have trouble thinking clearly?	1. Yes	2. No
9.	Do you feel unhappy?	1. Yes	2. No
10.	Do you cry more than usual?	1. Yes	2. No
11.	Do you find it difficult to enjoy your daily activities?	1. Yes	2. No
12.	Do you find it difficult to make decisions?	1. Yes	2. No
13.	Is your daily work suffering?	1. Yes	2. No
14.	Are you unable to play a useful part in life?	1. Yes	2. No
15.	Have you lost interest in things?	1. Yes	2. No
16.	Do you feel that you are a worthless person?	1. Yes	2. No
17.	Has the thought of ending your life been on your mind?	1. Yes	2. No
18.	Do you feel tired all the time?	1. Yes	2. No
19.	Do you have uncomfortable feelings in your stomach?	1. Yes	2. No
20.	Are you easily tired?	1. Yes	2. No

12.2. Published Original Papers/ and/or manuscripts

Paper I-Magnitude and trends of under-five mortality

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BMC Pediatrics

Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia: A community based study

Girma Temam Shifa*, Ahmed Ali Ahmed and Alemayehu Worku Yalew

Abstract

Background: Though, Ethiopia has shown progress in the reduction of under-five mortality in the last few years, the problem of neonatal and under-five mortality are still among the highest in the world and that warrants continuous investigation of the situation for sustained interventions to maintain the reduction beyond the millennium development goals. Therefore, this study was conducted with the objective of determining the magnitude of childhood mortalities in the designated community.

Method: A census of 11 kebeles (lowest administrative units in Ethiopia) of Arba Minch Town and 11 kebeles of Arba Minch Zuria District, which were not part of Arba Minch Demographic Surveillance System (DSS), had been done in order to identify all children (alive and dead) born between September 01, 2007 and September 30, 2014. Besides, all children born after July 01, 2009 were tracked from the database of the Arba Minch DSS. Descriptive analyses with frequency and cross tabulation with the corresponding confidence interval and p-value were made using SPSS 16 and STATA 11. Extended Mantel-Haenszel chi-square for linear trend was also performed to assess presence of linear trend through the study period using open-Epi version 2.3.

Result: A total of 20,161 children were included for this analysis. The overall weighted under five, infant and neonatal mortalities with their corresponding 95 % confidence intervals were: 42.76 (39.56-45.97), 33.89 (31.03-36.76) and 18.68 (16.53-20.83) per 1000 live births, respectively. Majority of neonatal deaths occurred within the first 7 days of life. Under-five mortality was found to be significantly higher among non-DSS rural kebeles, overall rural kebeles and females.

Conclusion: Significant number of children died during their early days of life. Strengthening of maternal and child health interventions during pregnancy, during and immediately after birth are recommended in order to avert majorities of neonatal deaths.

Keywords: Under five, Infant, Neonatal, Child, Mortality, Death, Determinants of mortality, Gamo Gofa, Ethiopia

Background

Unacceptably, every day 17,000 children die before their fifth birthday in the world, mostly from preventable and treatable causes. In actual number, only in 2013, 6.3 million children died before their fifth birth date. This is despite the existence of knowledge and technologies for life-saving interventions [1]. In 2012, about 75 % of all child deaths were attributable to just six conditions: child birth related neonatal causes, pneumonia, diarrhea, malaria, measles, and HIV/AIDS [2].

Inequities in child mortality between high income and low income countries continue to exist. For in- stance, in 2013 the under five-mortality rate in sub- Saharan African Region was the highest in the world, 92 deaths per 1000 live births, nearly 15 times the average in developed countries [1].

In Ethiopia, under-five mortality was reported to decline by 47 % over the 15-year period between the 2000 and the 2011 Ethiopian Demographic and Health Survey (EDHS) (declined from 166 to 88 deaths per 1000 live births). Infant mortality also decreased by 39 % over the same period, from 97 to 59 deaths per 1000

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live births[3]. Although such decline has been reported, child mortality rate in Ethiopia has been among the highest in the world, that about one in every 17 Ethiopian children dies before the first birthday, and one in every 12 children dies before the fifth birthday [3].

The neonatal (37 per 1000 live births) and post-neonatal (22 per 1000 live births) mortality rates were also high in the country, where relatively slow reduction was observed. Childhood mortality in the country is higher in rural areas than in urban areas [3]. Mortalities in Southern Nations, Nationalities and People's Region (SNNPR) were among the highest in the country. Under five, child, infant, post neonatal and neonatal mortalities in the Region were 116, 41, 78, 41 and 38 per 1000 live births, respectively [3]. Besides the periodic EDHS reports, few pocket studies which have been conducted in other parts of the country showed varying figures. Under-five mortality was ranging from 76 to 130 per 1000 live births, whereas infant mortality was ranging from 62 to 93.5 per 1000 live births [4–7]. However, these studies were basing only on few kebeles (lowest administrative units in Ethiopia) of DSS sites or they were not meant to assess the magnitude of childhood mortalities. For example, a study at the DSS site of Butajira, Ethiopia, reported an infant mortality rate of 62/1000 live births [4], though its main objective was not to assess the magnitude of infant mortality. In another DSS based study done in Dabat, Northern Ethiopia, the risk of infant death was 93.5 per 1000 live births, whereas under five mortality was 130 per 1000 live births [5]. A relatively recent study in the same DSS site (Dabat) showed infant mortality of 88 per 1000 person-years [8].

Another community based study in the northern part of the country reported, neonatal, post neonatal, infant, child and under five mortality rates of 37, 30, 67, 33 and 99 per 1000 live births respectively [6]. A study in the South West part of the country also reported neonatal and infant mortality rates of 38 and 76.4 per 1000 live births, respectively [7].

As the Arba Minch DSS (study site of the current study, which is located extreme south of the country) is new, under-five mortality studies are lacking in the area. The above mentioned studies are concentrated around central or northern part of the country that it may not be possible to have nationally representative summary of magnitude of the problem from these studies. Overall, Ethiopia has shown progress in the reduction of under-five mortality in the last few years; however, the problem is still among the highest in the world and warrants for continuous investigation of the problem for sustained interventions to maintain the reduction beyond the millennium development goals (MDGs). Therefore, this study was conducted with the objective of determining the magnitude of childhood mortalities in the designated community.

Methods

Study area

The study was conducted in Gamo Gofa Zone, which is one of the 14 Zones in the Southern Nations Nationalities and People's Region (SNNPR). The Zone has 15 districts (District s) and 2 town administrations. Arba Minch Town, the Capital of Gamo Gofa Zone, is 502 km south of Addis Ababa. Gamo Gofa Zone is a zone with two Lakes (Lake Chamo and Abaya). The Zone is known for its banana, apple and fish production which may impact child nutrition and survival. There were three hospitals and 68 health centers providing health services for the population during the study period. In 2014, the total population of the Zone was projected to be 1,901,953 (with 943,834 males and 958,119 female, 285,043 Urban (15 %) and 1,616,910 Rural (85 %) residents) [9].

Arba Minch Zuria District has been selected as study site for the current study, as it is the study site for the Arba Minch DSS which is relatively new site in the country and as the District h as three climatic/geographic zones (Dega(high land), Woina dega (mid land) and Kolla(low land)); which is suitable to represent population of different agro ecological zones. The District lies on 168,712 square kilometers and constitutes 29 kebeles (lowest administrative units in Ethiopia). The total population of the district was projected to be 185,302 (with 92,680 males and 92,622 female) in 2014. Arba Minch Town, which is the capital of the Zone, is included to represent the urban population of the Zone. The total population of the Town was projected to be 135,452 (with 68,132 males and 67,320 female) [9]. The Town was divided in to 11 urban kebeles. The Arba Minch DSS was established in 2009 in one of the districts in the Zone (Arba Minch Zuria District), which was part of the current study. Arba Minch DSS is based in 9 kebeles of the district. It was established by conducting base line survey/census during July 01-September 30, 2009. Since then, it has been tracking information on vital events (birth, death, migration etc.) continuously. The total population of the DSS was 59,875 with 12,241 female in the reproductive age (15-49), 9825 under-five and 2388 under one year of age children (2011 report of the DSS).

Study design and period

A cross-sectional study design was conducted to assess the magnitude of under-five mortality in 2014, as part of a doctoral thesis work "assessment of magnitude and determinants of under-five mortality and its effect on maternal mental health in Gamo Gofa Zone, Ethiopia".

Source and study population

The source population was all under-five children in the study area whereas, the study population was all children born between September 01, 2007-September 30, 2014.

Inclusion criteria

All children (alive and dead) together with their respective mothers born between September 01, 2007 and September 30, 2014 were included in the study.

Exclusion criteria

Those who were still births were excluded.

Sample size determination

The sample size was determined using single population proportion formula by considering the prevalence of under-five mortality to be 88/1000 [3]. By taking 95 % confidence level and 1.5 % margin of error, the minimum required sample size for the study was 1371. By applying a design effect of 1.5 and adding 5 % to compensate for non-response, a total of 2158 under five children were required. However, all children who had been identified during census of the selected kebeles were included in the analysis to increase the precision and able to estimate other categories of childhood mortality rates.

Sampling technique

Arba Minch Town and the Arba Minch Zuria District were selected purposively out of the 15 districts and 2 town administrations of the Zone. Then, all the 11 kebeles of Arba Minch Town and the 9 kebeles of the Arba Minch Zuria District which are part of the Arba Minch DSS were included (initially these kebeles were selected randomly out of 29 kebeles in the District) and additional 11 kebeles from those kebeles which were not part of the Arba Minch DSS were selected randomly. Accordingly, 31 kebeles from the two districts were included in this study (11 from Arba Minch Town and 20 from the Arba Minch Zuria District). This number was assumed to provide adequate number of sample for the subsequent studies.

Then, a census of the 11 non-DSS kebeles of the Arba Minch Zuria District and 11 kebeles of Arba Minch Town had been done in order to identify all children (alive and dead) born between September 01, 2007-September 30, 2014. The children were followed retrospectively by asking the respondent about whether the child was alive or dead at the time of the survey. If the child was dead, the date of death was recorded.

As the Arba Minch DSS has been tracking all births and deaths since its establishment in 2009, children born between August 01, 2009 and September 30, 2014 in Arba Minch DSS kebeles were tracked from the database of the DSS. Therefore the data since 2009 were tracked from all the 31 kebeles and the data since 2007 were tracked only from the 22 kebeles (Fig. 1).

Data collection

A pre-tested Amharic questionnaire was utilized for data collection. The questionnaire was developed in English and translated to Amharic, then back translated to English to check for its consistency. Finally, the Amharic Version was used for data collection. Variables in the questionnaire include: sex of the child, date of birth of the child, whether the child is alive or dead, if dead date of death and other identifiers (identification number (for the

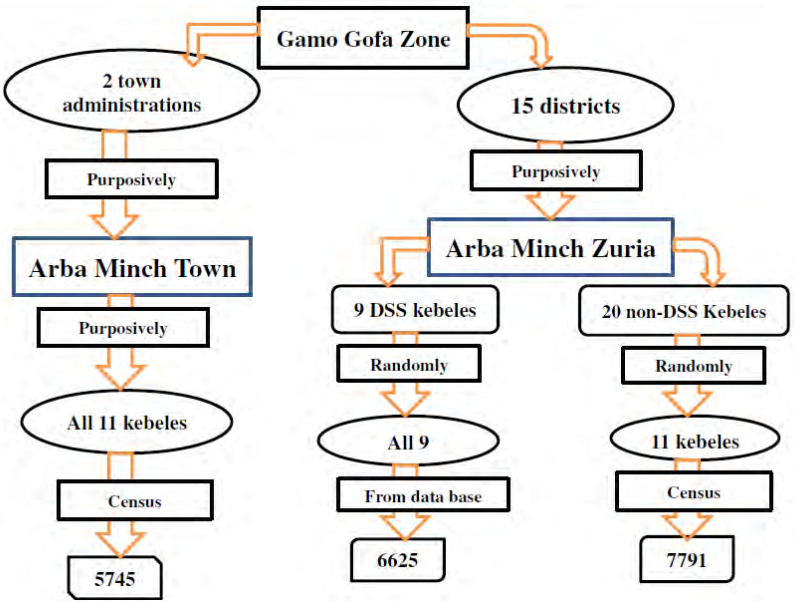

Fig. 1 Schematic presentation of the study districts and kebeles and their selection procedure

child and the mother), district name, kebele name, house number). At least two data collectors (grade 10 or above) per kebele were recruited and trained on the procedure. Four master holders (in Public Health) supervised the data collection process. The principal investigator had been strictly following the data collection throughout the process. Besides, additional data were sought from the kebele admirations and health posts through reviewing documents and/or interviewing the kebele officials or the health extension workers (HEWs) to determine characteristics of the kebeles.

Data processing and management

The data were edited, coded, entered into computer and cleaned using Epi Info Version 3.5.1 and the analysis was performed by open-epi version 2.3, SPSS version 16 and STATA 11 as appropriate. The daily collected data were transferred to the Arba Minch University and locked in a secure cabinet which was arranged in the compound of College of Health Sciences of the Arba Minch University on daily basis. The data were entered into Epi info by two data encoders after having training/orientation on the template, the procedures for insuring the quality of the data during data entry and the importance of quality of data. They were also expected to identify incomplete and inappropriate data and communicate to the principal investigator at this stage too. This was strictly followed and checked by the principal investigator on daily basis.

Data analysis

Descriptive analyses with frequency and cross tabulation with the corresponding confidence interval with p-value were made. As we collected data on complete live birth histories of all mothers within the last 7 years before the survey, we have applied a direct method to estimate mortalities.

Accordingly, birth cohort method was applied to determine overall level of childhood mortalities (only deaths of children born during the study period were included in the numerator). Whereas, death cohort method was used for trend analysis (deaths of children born prior to the target year may be included in the numerator of that year). Extended Mantel-Haenszel chi square for linear trend was also performed to assess presence of linear trend through the study period using open-epi version 2.3.

Weighted analysis was conducted to account for the non-proportional allocation of the sample to urban and rural kebeles. The sampling weight was calculated using the following notion: by determining sampling probability at two stages (district and kebele levels), as a complete census/coverage of individuals in selected kebeles was made.

$P(k^{th}$ individual in j^{th} kebele in i^{th} district being selected) = $P(i^{th}$ district being selected)$P(j^{th}$ kebele selected| i^{th} district is selected)$P(k^{th}$ individual selected| j^{th} kebele is selected, which is one (as a complete census was made)). Then the weights were the reciprocals of these probabilities [10].

Accordingly, the sampling weight for urban was: As one out of 2 urban districts was included and all the kebeles in selected district were included. The probability of selection of individuals in urban kebele = 1/2*1*1 = 0.5. The corresponding weight calculated to be 2. For that of rural: as one out of 15 rural districts was included, twenty out of 29 kebeles of the district were included. The probability of selection of individual in rural = 1/15*20/29*1 = 0.046. The corresponding weight calculated to be 21.8.

Data quality assurance

The questionnaire was pre-tested and corrections were made accordingly. Two days training was given to data collectors and supervisors on the questionnaire and the procedures. The data collection process was strictly followed up. All collected data were checked every day for their completeness, clarity and consistency by super- visors and the principal investigator. Any unclear and ambiguous data were corrected by recollecting data from actual study population by going back to the field, while minor errors were corrected by the principal investigator as deemed necessary. About 5 % of the households were re-visited by the supervisors/principal investigator to check the validity of the information collected by the data collectors. Then, data were cleaned and checked be- fore data entry and analysis again. Besides, double entry of 10 % of the questionnaire was made to monitor any discrepancies.

Ethical considerations

Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Letters were written to all concerned bodies (Gamo Gofa Zone Health Department, Arba Minch Zuria District and Arba Minch Town Health Office and administration of all kebeles) and per- missions were secured at all levels. After explaining about the purpose of the study and confidentiality of the data, verbal consent was obtained from each respondent. To assure the confidentiality of the responses, anonymous interviews were conducted. Besides, the daily collected data were transferred to the Arba Minch University and locked in a secure cabinet on daily basis.

Result

Basic characteristics of the study subjects/kebeles

Overall, 13536 children born between September 2007 and September 2014 were identified from the census of 11 kebeles of the Arba Minch Town and 11non-DSS rural kebeles of the Arba Minch Zuria District. Additional data from 6625 children born between August 2009 and

September 2014 were obtained from the Arba Minch DSS data base. A total of 20161 children were included for this analysis. Accordingly, 6625 (32.9 %), 7791 (38.6 %) and 5745 (28.5 %) of the children were from DSS sites, none DSS rural kebeles of Arba Minch Zuria District and Arba Minch Town, respectively.

Majority (27/31) of the kebeles had all-weather road.

More than half (19/31) of the kebeles were more than 10killo meters (kms) away from the serving hospital in the area (Arba Minch Hospital). Except one kebele, all the 30 kebeles were within 10kms from the nearby health center. M ajority (23/31) of the kebeles' staple food was maize. Most (19/31) of the kebeles were malarious. All kebeles had at least one HEW working in the kebele during the study period. Almost all (29/31) had at least two HEWs working in the kebeles. A maximum of 4 HEWs were found in some kebeles. In about half (14/31) of the kebeles, HEWs were providing delivery service at home or in the health post during the study period.

Overall, 10,375 (51.5 %) of the children were female giving a male to female ratio of 1:1.06. Majority (14,416 (71.5 %)) of the children were from rural kebeles. Five hundred eighty five (2.9 %) of the children were neonate. Three thousand eight hundred twenty five (19 %) of the children were less than one year old. Majority (13,512 (67.0 %)) of the children were from kola (low land) kebeles. Majority (71.5 %) of the children were living more than 10kms away from Arba Minch hospital. Whereas, 95.2 % of the children were living within 10kms distance of the nearby serving health center (Table 1).

Table 1 Socio-economic characteristic of the study subjects/study kebeles, Gamo Gofa Zone, 2014

Characteristics	Frequency	Percent
Distance from Arba Minch Hospital in KM of the household		
<=10km	5745	28.5
>10KM	14416	71.5
Distance from Nearby Health center in KM of the household		
<=10Km	19189	95.2
>10Km	972	4.8
Sex of the child		
Male	10375	51.5
Female	9786	48.5
Age category of the child		
Neonate	585	2.9
Post Neonate	3240	16.1
Infant	3825	19
Child	16336	81
Under-five	20161	100
Kebele category of the child		
DSS-Rural	6625	32.9
Non-DSS Rural	7791	38.6
Urban	5745	28.5
Climatic/agro-ecological Zone of the child		
Kola (low land)	13512	67.0
Weyna Dega (mid land)	2864	14.2
Dega (high land)	3785	18.8

Mortality rates

Overall description of un-weighted mortality

As depicted in Fig. 2, out of 20,161 children identified through the census of the 22 kebeles and the Arba Minch DSS, 815 died before their fifth birth day, providing an overall un-weighted under five mortality of 40/1000 live births. Of those, 282 died with in the first 7 days of birth, giving a n un-weighted early neonatal mortality rate of 14/1000 live births. Sixty six of the children died after 7 days but within one month of age, giving an un-weighted late neonatal mortality rate of 3/ 10 00 live births. Accordingly, overall un-weighted neonatal mortality (early plus late neonatal) was 17/1000 live births. Three hundred of the children died after one month but before their first birth day, giving un-weighted post neonatal mortality rate of 15/1000 live births. So, the overall un-weighted infant mortality (neonatal plus post neonatal) was 32/1000 live births. Besides, 167 of the children died after their first birth date but before their fifth birth date, giving un-weighted child mortality rate of 8/1000 live birth (Fig. 2).

It is evident from Fig. 2 that about 79 and 44 % of all under-five mortalities occurred before their first birth date and within the first one month of age, respectively. About 82 % of neonatal deaths occurred within the first 7 days of life (Fig. 2).

As displayed in Table 2, over all under-five mortality was significantly low in DSS kebeles (32/1000 live birth) and urban kebeles (34/1000 live birth) than in non-DSS rural kebeles (52/1000 live birth) of Arba Minch district. Infant and neonatal mortalities were also significantly high in non-DSS kebeles of Arba Minch Zuria district than DSS and urban kebeles (Table 2).

Description of weighted mortalities

In order to account for the non-proportional allocation of the kebeles/study subjects among urban and rural, a weighted analysis was performed as explained at the analysis part of the method above. As indicated in Table 2, the overall weighted under-five mortality with its 95 % confidence interval was 42.75 (39.55-45.96) per 1000 live births. The corresponding weighted mortalities per 1000 live births with their corresponding 95 % confidence interval were 8.87 (7.38-10.35) for child,

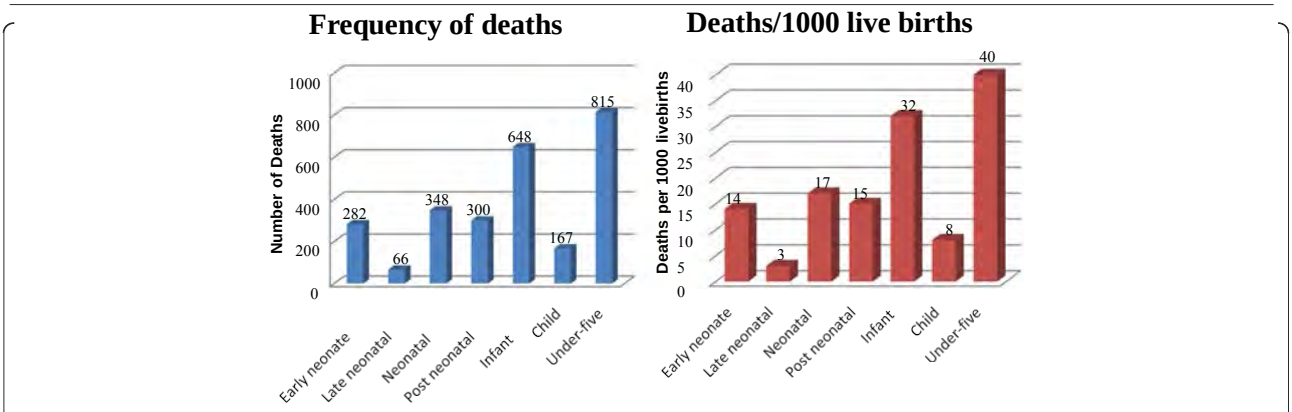

Fig. 2 Number of deaths and mortality rate by age category, Gamo Gofa Zone, 2014

33.88(31.02-36.75) for infant, 15.21 (13.28-17.15) for post neonatal, 18.67(16.52-20.81) for neonatal, 3.44 (2.51-4.37) for late neonatal and 15.23 (13.28-17.17) for early neonatal (Table 2).

Significant difference of mortality was observed among rural and urban children. Under-five mortality was found to be significantly higher among rural kebeles (death/1000 live birth and 95 % confidence interval (CI) of 43.08 (39.76-46.39)) than urban kebeles (death/1000 live birth and 95 % CI of 33.77 (29.10-38.44)). Neonatal mortality was also high in rural kebeles (death/1000 live birth and 95 % CI of 18.87 (16.65-21.09)) than urban kebeles (death/1000 live birth and 95 % CI of 13.23 (10.27-16.18)) (Table 2). There was significant difference of mortality among males and females. Under-five mortality was significantly high among males (death/1000 live birth and 95 % CI of 49.08 (44.54-54.06) than females (death/1000 live birth and 95 % CI of 35.92 (31.92-40.41). Similarly, significantly high infant and neonatal mortality rates were observed among males than female (Table 2).

Trends of mortality

In order to have full year mortality data to assess trends in child mortality, the data were reorganized in the Ethiopian calendar years (the calendar year starts at September). As displayed in Fig. 3, the result didn't show a significant change in under-five mortality throughout the study time ($X^2 = 0.75$, p-value = 0.39) in overall study kebeles. However, unlike other kebeles, under-five mortality in DSS kebeles found to be significantly decreasing ($X^2 = 10.16$, P = 0.001). More or less similar trends were observed in infant and neonatal mortalities, i.e., fluctuating trends in the overall and non-DSS rural and urban kebeles but sharp reduction in DSS kebeles (Fig. 3).

Discussion

The overall weighted under five, child, infant, post neonatal and neonatal mortalities were calculated to be 42.76, 8.87, 33.89, 15.22 and 18.68 per 1000 live births, respectively. These figures are lower than the national and regional reports of the latest EDHS 2011report [3]. The mortality rates identified by the current study are also lower than other pocket studies conducted in other parts of the country [4–8]. This may be because of socio-cultural differences in child caring and feeding practices of study populations. This was reflected by low prevalence of malnutrition (which is one of the leading causes of under-five mortality) in the study area (Zone) of the current study [11, 12]. The other reason may be due to time variation between the studies, as potential health service coverage has increased dramatically in the country in recent years. This was demonstrated by the current study that there were 100 % coverage of at least one health post and one health extension worker operating in the study kebeles of the current study and almost all the kebeles had access of health centers' service within 10kms distance. Though, the other studies were basing on only few DSS kebeles (unlike the current study which covered larger population including DSS kebeles), most of them were either based on retrospective birth experiences of mothers [5–7] or prospective data of DSS kebeles [4, 8]. However, still there might be under reporting of deaths (survivor se- lection bias) in the current study as most of the data were collected retrospectively in a longer duration (within the past seven years before the survey).

About 79 and 44 % of all under-five mortalities occurred before their first birth date and within the first one month of age, respectively. Relatively, similar trend was observed in the 2011 EDHS report [3], in which 67 and 42 % of all under-five mortalities occurred before their first birth date and within the first one month of age, respectively. The occurrence of high mortality especially during post neonatal period might be attributed to infection mainly diarrheal disease, since this is the time when supplementary foods are started (given the poor hygienic condition of rural population of developing countries).

Table 2 Mortality rates by: urban-rural, 3 categories of kebeles and sex of the child, Gamo Gofa Zone, 2014

Age category	By the three categories of kebeles (Un-weighted data)	Mortality/1000 Live births	[95 %	Conf. Interval]	P-value
Under-five	Non-DSS Rural	52.24	47.30	57.18	1
	Urban	33.77	29.10	38.44	0.001
	DSS	32.30	28.04	36.56	0.001
Neonatal	Non-DSS Rural	25.54	22.04	29.05	1
	Urban	13.23	10.27	16.18	0.001
	DSS	11.02	8.50	13.53	0.001
Infant	Non-DSS Rural	41.20	36.79	45.62	1
	Urban	27.15	22.95	31.36	0.001
	DSS	25.81	21.99	29.63	0.001
Child	Non-DSS Rural	11.04	8.72	13.36	1
	Urban	6.61	4.52	8.71	0.001
	DSS	6.49	4.56	8.42	0.001
Age category	By rural–urban (Weighted data)	Mortality/1000 Live births	[95 %	Conf. Interval]	P-value
Under-five	Over all	42.75	39.55	45.96	
	Rural	43.08	39.76	46.39	1
	Urban	33.77	29.10	38.44	0.003
Early Neonatal	Over all	15.23	13.28	17.17	
	Rural	15.40	13.39	17.41	1
	Urban	10.44	7.82	13.07	0.007
Late neonatal	Over all	3.44	2.51	4.37	
	Rural	3.47	2.51	4.43	1
	Urban	2.79	1.42	4.15	0.444
Neonatal	Over all	18.67	16.52	20.81	
	Rural	18.87	16.65	21.09	1
	Urban	13.23	10.27	16.18	0.006
Post neonatal	Over all	15.21	13.28	17.15	
	Rural	15.26	13.26	17.26	1
	Urban	13.93	10.90	16.96	0.480
Infant	Over all	33.88	31.02	36.75	
	Rural	34.13	31.17	37.09	1
	Urban	27.15	22.95	31.36	0.011
Child	Over all	8.87	7.38	10.35	
	Rural	8.95	7.41	10.49	1
	Urban	6.61	4.52	8.71	0.100
Age category	By Sex of the children (Weighted data)	Mortality/1000 Live births	[95 %	Conf. Interval]	P-value
Under-five	Male	49.08	44.54	54.06	1
	Female	35.92	31.92	40.41	0.001
Infant	Male	39.50	35.43	44.01	1
	Female	27.83	24.32	31.83	0.001
Neonatal	Male	24.15	20.99	27.78	1
	Female	12.76	10.44	15.59	0.001

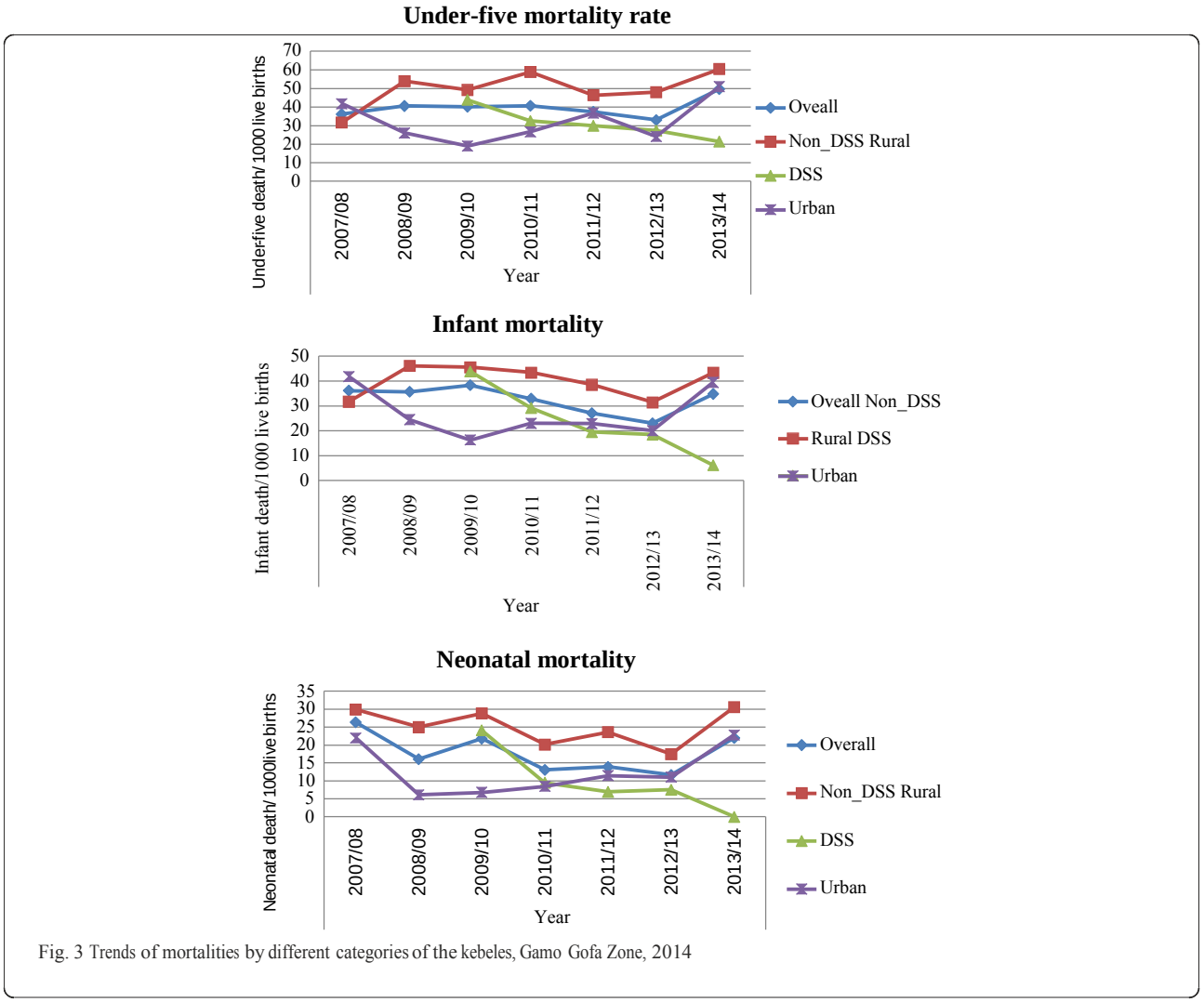

Fig. 3 Trends of mortalities by different categories of the kebeles, Gamo Gofa Zone, 2014

On the other hand, about 82 % of neonatal deaths occurred within the first 7 days of life. This was in spite of the above mentioned high potential health coverage of the study kebeles. It may be because of poor quality of maternal and child health services provided to the community, as health service delivery systems in developing countries have been criticized for failing to bring expected results at expected level, partly because of poor quality [13]. All these may signify importance of investigating quality of health services to improve and strengthen maternal and child health interventions during pregnancy, during and immediately after birth (through antenatal care (ANC), skilled birth attendance and early post natal care). This may help to avert majority of neo- natal mortalities, as early neonatal mortalities are mainly caused by pregnancy and child birth related problems; including birth asphyxia, prematurity, maternal hyper- tension and obstetric hemorrhage [14–16].

Significantly, higher rate of under-five mortality was encountered among rural kebeles than in urban kebeles. Similar observation was found in the EDHS 2011 [3] report. This may be due to the relatively better access to health services and utilization of the services by urban population as a result of a relatively better awareness of the benefit of the health service.

Similar to the EDHS 2011 report [3], under-five mortality rate was significantly higher among males than in females in the current study. Similar finding was observed in a study which analyzed DHS data from sub Saharan African countries including Ethiopia's EDHS 2011 data [17]. This may be owing to biologic differences of the two sexes, as genetic factors were reported to be reasons for higher mortality among males than females [18–20].

Unlike the other kebeles, under-five mortality significantly decreased in DSS kebeles during the study period. More or less similar trends were observed in infant and neonatal mortality, i.e., fluctuating trends in the overall and in non-DSS rural and urban kebeles but sharp reduction in DSS kebeles. Relatively low under-five mortality was also observed in DSS kebeles than non-DSS kebeles

of the Arba Minch Zuria District and urban kebeles. This may be due to effect of frequent contact of data collectors, supervisors and researchers with the community which is not true in non-DSS sites. This might create more concern and motivation of HEWs and other health cadres working in the kebeles, because they knew mortalities are continuously monitored by the Project. Or it might create awareness about service utilization and child care in the communities owing to frequent visiting and questioning of the households to fill the questionnaires by data collectors of the Project. Previous study in India revealed that, health education by visiting homes of the mothers had positive maternal behavior change that may positively affect child survival [21]. Similarly, frequent home visit by lay volunteers was shown to improve treatment outcome of tuberculosis in Iraq [22]. However, as DSS sites are becoming sources of evidence for magnitude and cause of mortalities in areas where vital event registrations are lacking (in Africa, Asia and Oceania) [23, 24], we suggest further investigation of whether such variations exist in other sites or not and the reasons of such variations.

Finally, this study covered a large number of populations from urban and rural kebeles and kebeles of different climatic/agro-ecological zones and DSS and non-DSS sites. However, the followings should be taken into consideration in interpreting the findings. There may be recall bias in determining date of birth and date of death, as most of the data were collected retrospectively. However, in majority cases we used the child's immunization card. In the absence of immunization card we applied local calendars with the help of HEWs. There may be under reporting of deaths (survivor selection bias) especially for early child deaths, which may underestimate the rates. Some of the associations reported in this analysis may be confounded by other factors.

Conclusions

The overall under-five mortality of the study area was found to be 43 per 1000 live births. The under-five mortality in the study area was lower than the national and regional reports. As significant numbers of children are dying during their early days of life in spite of high potential health coverage, investigation of quality of health services and strengthening of maternal and child health interventions during pregnancy, during and immediately after birth may help to avert majorities of neonatal mortalities. The mortality rates are significantly higher among rural communities than their urban counterparts. Therefore, child health interventions should give due attention, especially to those areas with low coverage of child and maternal health services. Finally, in order to address factors contributing for the continued risk of under-five mortality, study identifying the independent contributors of under-five mortality in the area need to be conducted. Besides, the actual reason for the relatively low rate of childhood mortality in DSS kebeles should be explored.

Abbreviations

ANC: antenatal care; CI: confidence interval; DSS: demographic surveillance site; EDHS: Ethiopian demographic and health survey; HEWs: health extension workers; MDGs: Millennium development goals; SNNPR: Southern nations, nationalities and people's region; WHO: World Health Organization.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Conceived and designed the study: GTS AAA AWY. Conducted the study: GTS AAA AWY. Analyzed the data: GTS AAA AWY. Wrote the paper: GTS AAA AWY. Read the final manuscript and approved for submission: GTS AAA AWY.

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References

1. Unite Nation Inter-agency Group for Child Mortality Estimation ((UN IGME). Levels & Trends in Child Mortality. 2014. URL: http://www.unicef.org/media/files/Levels_and_Trends_in_Child_Mortality_2014.pdf. Accesssed on 03 March 2015.
2. World Health Organization. Western Pacific Representative Office Lao People Democratic Republic. 2016. URL: http://www.who.int/topics/millennium_development_goals/child_mortality/en/. Accessed on 03 March 2016.
3. Ethiopia Demographic and Health Survey: Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ORC Macro. 2011.
4. Adewuya AO, Hanlon C, Medhin G, Dewey M, Alem A, Worku B, et al. Perinatal common mental disorders and child survival in Ethiopia. J Paediatr Child Health. 2014;50(1):57–63.
5. Okwaraji YB, Cousens S, Berhane Y, Mulholland K, Edmond K. Effect of geographical access to health facilities on child mortality in rural Ethiopia: a community based cross sectional study. PLoS One. 2012;7(3):e33564.
6. Yigzaw M, Enquselassie F. Birth Spacing and Risk of Child Mortality at Kalu District South Wollo Zone of Amhara Region, North East Ethiopia. Ethiop Med J. 2010;48(2):105–15.
7. Amare D, Fasil T, Belaineh G. Determinants of under-five mortality in Gilgel Gibe Field Research Center, Southwest Ethiopia. Ethiop J Health Dev. 2007;21(2):117–24.
8. Biks GA, Berhane Y, Worku A, Gete YK. Exclusive breast feeding is the strongest predictor of infant survival in Northwest Ethiopia: a longitudinal study. J Health Popul Nutr. 2015;34:9. doi:10.1186/s41043-015-0007-z.
9. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions: At Wereda Level from 2014 – 2017. 2013, Addis Ababa, Ethiopia.
10. Lohr SL. Sampling: Design and Analysis. Pacific Grove: Brooks/Cole; 1999.
11. Agedew E, Chane T. Prevalence of Stunting among Children Aged 6–23 Months in Kemba District , Southern Ethiopia: A Community Based Cross-Sectional Study. Advances in Public Health. 2015;2015:1–6. URL: http://dx.doi.org/10.1155/2015/164670. (Accessed on July 2 2015).
12. Tafese B, Desalegn K, Tigist F, Tsehai A, Tadese F, Tesfaye H, Menen Z. Effect of Nutrition Education on Feeding Practices and Nutritional Status of 6-23 Months Old Children at Demba Gofa and Geze Gofa Districts, Gamo Gofa Zone, SNNPR. Research abstract presented on Ethiopian Public Health

institution's research finding dissemination workshop. URL: http://www.ephi.gov.et/images/pictures/PPT_Tafese.pdf (Accessed on July 2 2015).
13. Ruger JP, Kim HJ. Global health inequalities: an international comparison.
J Epidemiol Community Health. 2006;60(11):928–36.
14. Ngoc NT, Merialdi M, Abdel-Aleem H, Carroli G, Purwar M, Zavaleta N, et al.
Causes of stillbirths and early neonatal deaths: data from 7993 pregnancies in six developing countries. Bull World Health Organ. 2006;84(9):699–705.
15. Allanson ER, Muller M, Pattinson RC. Causes of perinatal mortality and associated maternal complications in a South African province: challenges in predicting poor outcomes. BMC Pregnancy Childbirth. 2015;15:37.
16. Ersdal HL, Mduma E, Svensen E, Perlman J. Birth asphyxia: a major cause of early neonatal mortality in a Tanzanian rural hospital.
Pediatrics. 2012;129(5):e1238–43.
17. Adedini AS, Akinyemi OJ, Odimegwu C, Stephen AA. Sex differentials in childhood mortality revisited: evidence from subSaharan Africa. URL: http:// iussp.org/sites/default/files/event_call_for_papers/IUSSP_Sex%20differentials%20in%20childhood%20mortality%20in%20SSA.pdf Accessed: May 17, 2015.
18. Malwade BA. Is Discrimination in Food Really Necessary for Explaining Sex
Differentials in Childhood Mortality? Popul Stud. 1989;43(2):193–210.
19. Koenig MA, D'Souza S. Sex differences in childhood mortality in rural Bangladesh. Soc Sci Med. 1986;22(1):15–22.
20. Muhuri PK, Preston SH. Effects of Family Composition on Mortality Differentials by Sex Among Children in Matlab, Bangladesh. Popul Dev Rev. 1991;17(3):415–34.
21. Sankoh O, Byass P. Cause-specific mortality at INDEPTH Health and Demographic Surveillance System Sites in Africa and Asia: concluding synthesis. Glob Health Action. 2014;7:25590. URL: http://www.globalhealthaction.net/index. php/gha/article/view/25590. (Accessed on Jan 12, 2016).
22. Sheth M, Obrah M. Diarrhea prevention through food safety education. Indian J Pediatr. 2004;71(10):879–82.
23. Mohan A, Nassir H, Niazi A. Does routine home visiting improve the return rate and outcome of DOTS patients who delay treatment? East Mediterr Health J. 2003;9(4):702–8.
24. Streatfield PK, Khan WA, Bhuiya A, Hanifi SM, Alam N, Ouattara M, et al.
Cause-specific childhood mortality in Africa and Asia: evidence from INDEPTH health and demographic surveillance system sites. Glob Health Action. 2014;7:25363. URL: http://www.ncbi.nlm.nih.gov/pubmed/25377325. (Accessed on Jan 12, 2016)

Paper (Manuscript) II- Socioeconomic and Environmental Determinants of Under-Five Mortality

Socioeconomic and Environmental Determinants of Under-Five Mortality in Gamo Gofa Zone, Southern Ethiopia: A matched case control study

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Abstract

Background: Despite substantial progress has been made since the 1990s in reducing childhood mortality globally, high number of children still die before their fifth birthday every day. Different factors have been studied and implicated for under-five mortality with mixed results. Mortality studies in the current study sites were lacking. Therefore, this study was conducted to assess environmental and socioeconomic determinants of under-five mortality.

Methods: A matched case control study design was employed with 381 cases of children who died before their fifth birth date and 762 controls born within one month in the same locality as the case. Weighted conditional logistic regression was used to assess the association between factors and mortality status.

Result: The odds of death was found to be significantly low among children of mothers whose educational status was grade nine or above (Adjusted odds ratio (AOR) of 0.34(0.16-0.72)). Whereas, the odds of death was significantly high among children whose mothers' marital status were separated/divorced or widowed (AOR of 3.60(1.23-10.47)) and whose fathers were daily laborers (AOR of 2.34(1.29-4.23)). Presence of separate kitchen in the household for cooking was proximate factor which was significantly associated with under-five mortality with AOR of 1.77(1.16-2.70).

Conclusion: Socioeconomic factors like maternal education, husband occupation and marital status of the mother were shown to be significantly associated with under-five mortality. Hence, in order to enhance reduction in childhood mortality, investing on maternal education by targeting those at risk groups is recommended.

Key words: Under-five mortality, infant mortality, childhood mortality, determinants of under-five mortality, Gamo Gofa, Ethiopia

Background

Different factors have been studied and implicated for the continued high rate of under-five mortality in the world in general and in developing countries in particular with mixed results. For example, it is generally expected that the wealth status of a household is inversely associated with childhood mortality. This has as well been supported by findings of different studies [1-3]. However, a number of studies in developing countries showed a non-significant effect of socio-economic status of individual household on under-five mortality [4-10].

Access to safe drinking water and improved sanitation facilities are household characteristics which are generally considered as part of strategies to reduce infant and child mortality [11, 12]. In congruent with this notion, positive association between presence of latrine facilities in the household and childhood mortality was reported by other studies [13, 14]. However, findings which were contradicting with this fact were reported by others [7, 8, 10].

The total number of household members (household size) was assumed to influence childhood mortality; however, the expected effect of this variable has not been uniform or clear. A larger number of household members could imply higher fertility levels and a fiercer competition for resources there by increasing the risk of childhood mortality. But it may imply a larger number of potential caregivers residing in the household there by decreasing the risk of mortality. The latter is supported by study by Uddin et al [15].

It has been frequently argued that maternal education, assumed to be a vital indicator of maternal status in the household, is an important factor explaining risk of infant and child mortality. For example, maternal education was shown to positively affect child survival by many studies [14, 16-19], the effect is notable among older children than neonates [18]. Several hypotheses have been suggested to explain this association. It is postulated that maternal education inculcates modern health knowledge, beliefs and practices; improves the effectiveness of health behavior (feeding practices, child care etc.); and changes the mother's role within the family, enabling her to take the necessary measures to prompt child health, including effective use of modern health services[20].

Mothers are more likely to use scarce resources for the benefit of their children if they are free to

do so [21]. Mothers with greater autonomy may also benefit in other ways that indirectly affect their children. For example, they make greater use of antenatal care (ANC), delivery and postnatal care services [22] and contraceptives [23]. Albeit the effect of maternal autonomy on health service utilization was shown to vary on socio-economic status of the region where the mother was living [22]. This could affect her child's birth weight, morbidity and her own nutritional status. However, the findings were not universal that, in some studies [18], there does not appear to be any clear correlation between women's empowerment (participation in decision-making processes) in the household and childhood mortality.

Many hypotheses could be stipulated with regard to the association between maternal working status and survival status of her child. A working mother may have a good income to pay for food and other health interventions, which may positively affect survival of the child. On the other hand, working mothers may lack time to care for their children's health; this may negatively affect survival of the children. A study by Kishore and Parasuraman [24] showed that there was negative relationship between maternal work and infant and child survival, especially for male children.

Besides such mixed reports about socioeconomic and environmental determinants of childhood mortality by studies, because of the change in the life style of nations, partly due to globalization, determinant factors of childhood mortality may vary through time globally in general and in Ethiopia in particular. This may demand continuous investigation of different categories of factors which were identified as determinants in the past by including emerging factors or factors which had contradicting results. Therefore, this study investigated environmental and socio economic determinants of under-five mortality in Gamo Gofa Zone, southern Ethiopia, to identify areas to be focused on in order to sustain the reduction of childhood mortality and improve survival.

The analysis of the association between socioeconomic and environmental related variables and under-five mortality was determined using Henry Mosley and Lincoln Chen's analytic framework for the study of determinants of childhood mortality [25]. According to them socio-economic variables operate through a set of proximate determinants that directly influence the risk of disease and the outcome of disease processes. They identified three categories of distal

factors (individual, household and community level). In this work community level factors were controlled at design level by matching the cases and control by their place of residence. The framework also defines the following five categories of proximate determinants of childhood mortality: 1) Maternal factors, 2) Environmental Contamination, 3) Nutrient deficiency, 4) Personal illness control and 5) Injury. This paper focused on the distal (socioeconomic) factors and environmental contamination related factors as the other proximate factors were the focus of another paper of the authors (this work is part of a PhD thesis of the principal author). The adapted conceptual frame work for the overall determinants of childhood mortality is summarized below (Fig 1).

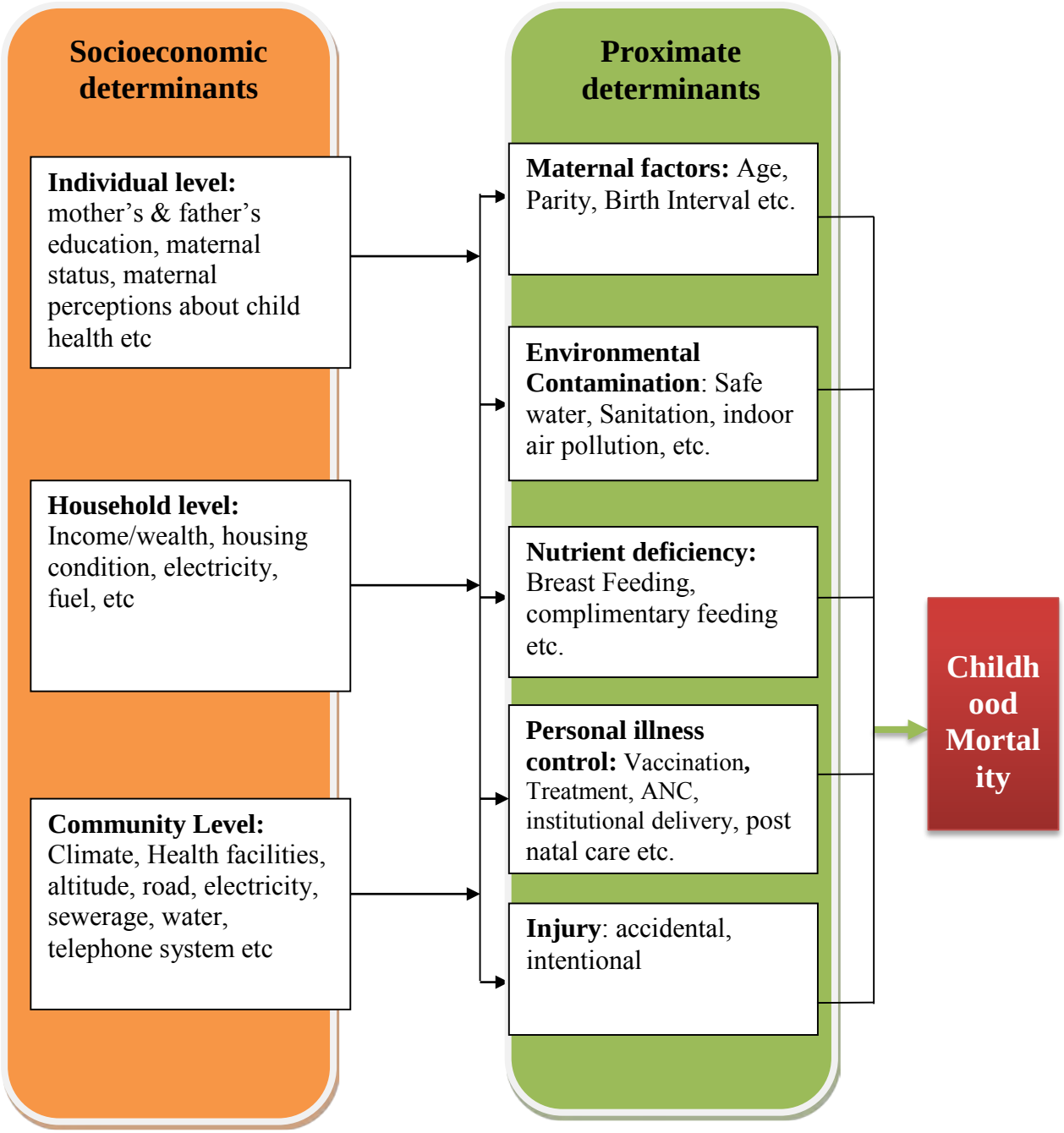

Figure 1: Conceptual framework showing the operation of proximate and socioeconomic determinants of under-five mortality (adapted from Henry Mosley and Lincoln Chen's analytic framework for the study of determinants of childhood mortality)

Methodology

Study area

The study area, Gamo Gofa Zone, has 15 Districts (woredas) and 2 town administrations. Arba Minch Town is the capital of Gamo Gofa Zone and is 502km south of Addis Ababa (capital of Ethiopia). Gamo Gofa Zone is known for its banana, apple and fish production that may impact child nutrition and survival. Three hospitals and 68 health centers were providing health services in the Zone during the study period. The total population of the Zone was projected to be 1,901,953 (with 285,043 Urban (15%) and 1,616,910 Rural (85%) residents) [26]. The study was conducted in one rural district (Arba Minch Zuria District) and one town administration (Arba Minch Town) of the Zone. Arba Minch Zuria District was selected as it is the study site of the Arba Minch Demographic Health System (DSS), which is relatively new site in the country and as the District has three climatic/ geographic zones (Dega (high land), Woina dega (mid land) and Kolla(low land)); which is suitable to represent population of different agro ecological zones. The District has 29 kebeles (lowest administrative units in Ethiopia) with a total population of 185,302 (with 92,680 males and 92,622 female) [26]. Arba Minch Town was included to represent the urban population of the Zone. The Town is divided in to 11 urban kebeles with a total population of 135,452 (with 68,132 males and 67,320 female) [26]. A further detail of the study area is presented elsewhere *[27]*.

Study Design and Period

A matched case control study, with cases of under-five children who died before their 5th birth date between March 01, 2011 and September 30, 2014, and two controls of alive children for each case, who were born within one month of age and in the same locality as the case, was conducted.

Sample size determination

The sample size was calculated using the statcalc command of Epi info 7 statistical software package. The prevalence of exposures (selected determinants) among controls and odds ratios (OR) were estimated from previous studies [28-31]. Then, the sample size required for detecting an estimated odds ratio of at least 1.75 with a two-sided probability of type I error of 5% and a

power of 80% was determined for all main variables with control to case ratio of two. Then, the maximum sample size was taken. Accordingly, the sample size corresponding to wealth index (prevalence of low wealth index among controls estimated to be 73.9% [29]) was taken. Hence, a minimum of 241 cases and 482 controls were required. By applying a design effect of 1.5 and adding 5% to compensate for non-response, a total of 380 cases and 760 controls were required.

Sampling technique

Arba Minch Town and the Arba Minch Zuria District have been selected purposively out of the 15 districts and two Town administrations of the Zone. Then, census of all the 11 kebeles of Arba Minch Town and randomly selected 11 non-DSS kebeles of Arba Minch Zuria District was conducted. Besides, data from nine kebeles of Arba Minch DSS were included (initially these kebeles were selected randomly out of 29 kebeles of Arba Minch Zuria District). The Arba Minch DSS has been tracking all births and deaths since its establishment in 2009. Accordingly, 31 kebeles from the two districts were included in this study (a further detail of this part is presented elsewhere [27]). From the census and the Arba Minch DSS, 383 cases that fulfilled the inclusion criteria were identified. And all of them with their corresponding matched and randomly selected 766 controls were approached.

Data collection

A pre-tested close ended structured Amharic questionnaire was utilized for data collection. The questionnaire was developed in English based on literatures and previous pertinent experiences and translated in to Amharic, then back translated to English to ensure for its consistency. Finally, the Amharic version was used for data collection. Two data collectors (at least certificate holders after completing grade 10) per kebele were recruited and trained on the procedure. Four supervisors who had master's degree supervised the data collection. The principal investigator strictly followed the data collection process.

Measurements and operational definitions

Dependent variable: Mortality status (dead or alive) of the index child

Independent variables: Socio economic and environmental contamination related characteristics

Wealth index: was computed using principal component analysis (PCA) of reported ownership of household assets.

Maternal power: was also computed using PCA of 8 variables which measure decision power of the mother in the household.

Data processing and management

The data were edited, coded, entered into computer and cleaned using Epi Info Version 3.5.1. The analysis was performed using STATA version 11. The daily collected data/questionnaires were transferred to Arba Minch University on daily basis. The data were cleaned by checking completeness and appropriateness of all raw data by supervisors and principal investigator before accepted as completed and kept in locked cabinet. The data were entered into Epi info by two experienced and trained data encoders. Data entry was strictly followed and checked by the principal investigator on daily basis. Double entry of 10% of the questionnaires was made.

Data analysis

To determine the effect of distal (socio-economic) and proximate (environmental contamination) factors on mortality of the child, weighted conditional logistic regression was conducted. The sampling weight was taken as the reciprocal of probabilities of selection, which was calculated as follows. The probability of selection for urban was =1/2*1*306/5745=0.027 (as one out of two urban districts and all the kebeles in selected district were included. Three hundred six out of 5745 children identified by the census were included). The corresponding sampling weight for urban was 37.6. For that of rural =1/15*20/29*837/14416=0.0027(as one out of 15 rural districts, twenty out of 29 kebeles of the district were included and 837 out of 14416 children identified were included in the study). The corresponding sampling weight for rural was 374.6.

Two consecutive models for under-five children and infants were fitted based on the Mosley & Chen's analytical framework for the study of determinants of childhood mortality [25]. According to Mosley & Chen's analytical framework distal factors like socioeconomic factors operate through proximate factors such as environmental contamination factors to affect childhood mortality. Accordingly, first model for distal factors was fitted. Then, those distal

factors which were significant at p-value of 0.1 were controlled for models of proximate variables (environmental contamination factors). Sex of the child was also controlled in both models.

Model diagnostic was conducted following each model using different STATA commands. Presence of specification error in the link term (logistic) or predictors was assessed with linktest command. Besides, the goodness of fit of the models was assessed by log likelihood chi-square test and Akaike Information Criterion (AIC) using estat ic command. Presence of interaction/effect modification was also assessed for suspected variables in both models. Multicollinearity among predictors was assessed for each model and tolerance value <=0.1 or variance inflation factor (VIF) of >= 10 was taken as an indicator of presence of multicollinearity.

Result

Socioeconomic-demographic characteristics of the respondents

All the 383 cases identified from the census and Arba Minch DSS and their corresponding 766 controls were approached for this study, but data from 381 cases and 762 controls were retrieved from 11 urban and 20 rural kebeles. Data from two cases and their corresponding controls were not retrieved since the respective cases migrated out from their initial location.

As displayed in table 1 below, 210(55.1%) of cases and 382(50.1%) of controls were males. Majority of mothers of cases 332(87.1%) and controls 688(90.3%) were age between 18 and 35 years. Most of mothers of the cases 251(65.9%) and the controls 517(67.8%) were protestant. With regard to the maternal education, more than half 210(55.1%) of cases and less than half 362(47.5%) of controls had no formal education.

Ethnically, majority of mothers of cases 286(75.1%) and controls 571(74.9%) were Gamo. Most of mothers of cases 264(69.3%) and controls 539(70.7%) were housewives. Majority of mothers of cases 358(94.0%) and controls 731(95.9%) were married. Nearly half of the husband of the cases 190(50.1%) and controls 433(56.8%) were farmers. With regard to husband education, 133(37.2%) of the cases and 228(31.2%) of controls lacked formal education. In terms of wealth index, only 124(32.5%) of the cases were classified as rich, whereas, 328(43.0%) of the controls were classified as rich (table 1).

Association of socioeconomic characteristics (distal factors) with under-five mortality

As it is shown in table 2 (model 1), the adjusted weighted conditional logistic regression revealed that among distal factors maternal education, husband occupation and marital status of the mother were factors significantly associated with under-five and/or infant mortality.

The odds of death among under-five children of mothers whose educational status was grade nine or above was about 66% (adjusted odds ratio (AOR) of 0.34(0.16-0.72)) less than among children of mothers who lacked formal education. Similarly, educational status of the mother was shown to be inversely associated with infant mortality (AOR of 0.37(0.15-0.91)) (table 2).

The odds of death among under-five children whose mothers' marital status were in other category (separated/divorced or widowed) were about 4 times (AOR of 3.60(1.23-10.47)) higher than among whose mother were married. Similarly, infants whose mothers' marital status were in other category (separated/divorced or widowed) had about 7 times (AOR of 6.68(1.81-24.71)) higher rate of odds of death than whose mother were married (table2).

Under-five children whose fathers were daily laborers had about 2 times (AOR of 2.34(1.29-4.23)) higher rate of odds of death than those whose fathers were farmers. Though it is not significant, infants whose fathers were daily laborers had about 1.8 times (AOR of 1.79(0.86-3.74)) higher rate of odds of death than those whose fathers were farmers (table2).

Though the association between wealth index of the household and under-five mortality was in the expected direction (children of poor families had a higher rate of odds of death), it was not statistically significant with AOR of 1.49(0.85-2.62) for average and AOR of 1.52(0.93-2.48) for poor when compared with rich categories. Index of maternal power in the household was not significantly associated with under-five mortality with AOR of 1.48(0.69-3.19) for average and AOR of 0.91(0.65-1.28) for good when compared with the poor categories. Other distal factors which were not statistically significantly associated with under-five and infant mortality were family size, mother's occupation, religion and ethnicity of the mother (table2).

Association of environmental contamination (proximate) factors with under-five mortality

Among factors classified as environmental contamination; presence of separate kitchen was significantly associated with both under-five and infant mortality. The odds of death among under-five children from a household which lacked separate kitchen for cooking was about 1.8 times (AOR of 1.77(1.16-2.70)) higher than among those with kitchen. Similarly, infants from household which lacked separate kitchen had about 1.9 times (AOR of 1.94(1.13-3.33)) higher rate of odds of death than those with kitchen. The odds of death among infants whose household's source of light was electricity was less (with AOR of 0.47(0.23-0.99)) than among those whose source is other than electricity (table3).

Surprisingly, presence or type of latrine was not significantly associated with under-five mortality with AOR of 1.03(0.60-1.76) for pit latrine and AOR of 1.37(0.50-3.73) for ventilated

and improved pit (VIP)/ flush toilet when compared to no latrine. Similarly source of water was not significantly associated with under-five mortality with AOR of 0.92(0.51-1.66) for protected well/spring and AOR of 1.02(0.61-1.72) for unprotected well/spring/river/pond when compared with tap water. Environmental contamination related factors like presence of window and sharing the house with animals were also not significantly associated with under-five and infant mortality (table 3).

Discussion

This study tried to identify socioeconomic and environmental determinants of childhood mortalities by aggregating predicting variables into relevant levels (distal or proximal factors) in order to determine unbiased effects of identified determinants. To achieve this, among others, efforts like matching of cases and controls at design stage and employment of weighted conditional logistic regression at analysis stage were made. However, as information was collected retrospectively systematic errors such as recall and social desirability biases may affect some of the findings. Besides, in controlling confounding factors, especially in the second model (for environmental contamination related factors), we may not be exhaustive in addressing other confounding factors. However, it is possible to assume that the confounding effect of proximate variables could be at least partially controlled by controlling distal factors, which are assumed to be operating through these proximate factors.

Among distal factors maternal education was shown to be important determining factor of under-five and infant mortality. Both infants and under-five children of mothers who were at least grade nine had less odds of death than those with no formal education. This finding is in line with many other studies conducted in different parts of the world [14, 16-19, 32]. This may be because of the effect of maternal education on modern health knowledge, beliefs and practices of the mother, that in turn could have effect on the effectiveness of health behavior (feeding practices and child care); and changes the mother's role in the family by enabling her to take the necessary measures, including effective use of modern health services such as immunization, ANC, delivery, postnatal care and contraceptives [20, 22, 23, 33].

Another important distal factor identified as predicting factor of under-five mortality is husband's occupation. Children whose fathers were daily laborers had higher rate of odds of death than whose fathers were farmers. This may be due to the fact that occupation of a father is an indicator of socioeconomic status of the household and stability of the family. It is logical to expect being a farmer is better and stable economically than being daily laborer, provided that majority of the current study population were from rural kebeles.

Both infants and under-five children whose mother were separated/ divorced or widowed were more likely to have higher rate of odds of death than whose mother were married. This was in

line with other studies done in Africa, that children of married mothers were more likely to survive than unmarried ones [4, 13, 34]. This may be for obvious reason that, these mothers are more likely to be deprived of economically than the one who has husband because of lack of support from the husband, who are the one responsible for income of the household. Besides, married mothers would get support from their partners for utilization of health services during antenatal through to postnatal care. The insignificant effect of being single on under-five mortality observed in this study may be because of the fact that, single mothers are more likely to live with their parents and get the support to care for their children.

In this study, unexpectedly wealth index of the household was not statistically associated with under-five mortality. This was in contrast to other studies [1-3]. However, the current finding was in line with studies in developing countries where they showed non-significant effect of socio economic status of the individual household on under-five mortality [4-10]. This may be because of the definition of socio-economic status, as socio economic status was determined using principal component analysis of possession of household assets. Therefore, there may be under reporting of household assets by the study participants as this is usually perceived to be linked with taxation and eligibility for social supports by the government and non-government organization in the community.

Maternal decision power as measured in the current study was not statistically significantly associated with under-five mortality. This was in contrast to previous arguments of positive effect of maternal status on childhood mortality through its effect on her decision on child health [21, 35-37]. However, unclear correlation between women's empowerment (participation in decision-making processes) in the household and childhood mortality was reported by another study [18]. This may show that, mere decision power of the mother may not have effect on childhood mortality unless it is supported by awareness about her and the child's health. However, the difference may be because of the difference in defining maternal power, as educational status of the mother is a crucial element of her status in the household, but it is treated independently in the current study.

In developing countries, traditional use of household energy like cooking and heating with biomass fuels/coal is posing a serious threat to health by producing a variety of health damaging

pollutants [38] and is shown to be a risk factor for many causes of childhood mortalities[39, 40]. This was supported by the current study that, among factors classified as environmental contamination; presence of separate kitchen for cooking was significantly associated with under-five mortality. Similar effect was observed among infants.

Presence or type of latrine facility the household had and source of drinking water were not significantly associated with childhood mortality in this study. This finding was against others' arguments [11, 12] and findings [13, 14] of positive association between latrine facility and childhood mortality. However, our finding is in line with other studies [7, 10, 41]. This may be because of the fact that majority of latrine types in the study area were traditional pit latrines (92% were pit latrine) which are usually unclean and prone to contamination by vectors like flies, this may be a risk factor for those children who had improved latrine as they are more likely to use similar ground at least for playing. The other possible explanation may be, because of access of curative health services at community level for those illnesses which may arise from lack of latrine facilities or safe drinking water such as diarrhea, through health extension program, as all the kebeles of the current study had a health post with at least one health extension worker serving the community at grass root level. However, the effect of these factors on intermediate cause of child mortality such as diarrheal disease should not be ignored as their effect on the non-death outcomes of the child's health (nutritional status, growth, mental development etc) is of paramount importance [42, 43].

Conclusions

This study tried to identify socioeconomic and environmental contamination related factors of childhood mortality in the study area or in areas with similar setup by controlling potential confounding factors at design stage and during analysis. In this study, distal factors like maternal education, husband occupation and marital status of the mother shown to significantly affect under-five mortality. So, in order to maintain the reduction in childhood mortality, investing on maternal education by targeting those at risk groups is required.

Among factors classified as environmental contamination; presence of separate kitchen for cooking was significantly associated with low under-five mortality. Besides, using electricity as a source of light was shown to significantly reduce infant mortality. So, in line with production and distribution of electricity to reach all households in rural area, advocating to have separate kitchen for cooking is important, given that majority of the households are using traditional way of household energy sources like biomass fuels for cooking.

Even though presence or type of latrine facility the household had and source of drinking water were not significantly associated with childhood mortality in this study, effect of these factors on intermediate cause of child morbidity and mortality such as diarrheal disease should not be ignored as their effect on other non-death outcomes of the child's health like nutritional status, growth and mental development is paramount.

List of abbreviations

ANC: Antenatal care
AOR: Adjusted Odds Ratio
DSS: Demographic surveillance site
MDGs: Millennium development goals
PCA: principal component analysis
VIP: Ventilated and improved pit

Ethical considerations: Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Letters were written to all concerned bodies and permissions were secured at all levels. After explaining about the purpose of the study and confidentiality of the data, informed consent was obtained from each care takers of study participants. To assure the confidentiality of the responses, anonymous interviews were conducted. Besides, the daily collected data were transferred to Arba Minch University compound and locked in a secure cabinet on daily basis.

Consent to Publish: Not applicable

Competing interests: The authors declare that they have no competing interests.

Authors' contributions: Conceived and designed the study: GTS AAA AWY. Conducted the study: GTS AAA AWY. Analyzed the data: GTS AAA AWY. Wrote the paper: GTS AAA AWY. Read the final manuscript and approved for submission: GTS AAA AWY.

Availability of Data and Materials: The data supporting this publication are summarized with tables and figure in the manuscript. However, if the raw data is required, it can be accessed from the authors whenever required using appropriate procedure and format.

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References

1. Nattey C, Masanja H, Klipstein-Grobusch K: Relationship between household socio-economic status and under-five mortality in Rufiji DSS, Tanzania. *Glob Health Action* 2013, 6:19278.
2. Ezeh OK, Agho KE, Dibley MJ, Hall JJ, Page AN: Risk factors for postneonatal, infant, child and under-5 mortality in Nigeria: a pooled cross-sectional analysis. *BMJ open* 2015, 5(3):e006779.
3. Ettarh RR, Kimani J: Determinants of under-five mortality in rural and urban Kenya. *Rural and remote health* 2012, 12:1812.
4. Kanmiki EW, Bawah AA, Agorinya I, Achana FS, Awoonor-Williams JK, Oduro AR, Phillips JF, Akazili J: Socio-economic and demographic determinants of under-five mortality in rural northern Ghana. *BMC international health and human rights* 2014, 14:24.
5. Muluye S, Wencheko E. Determinants of infant mortality in Ethiopia: A study based on the 2005 EDHS data. Ethiop. J. Health Dev. 2012;26(2):72–77.
6. Hossain M, Islam M. Socio-economic Variables Affecting Infants And Children Mortality In Bangladesh. The Internet Journal of Health. 2008; 9(2), 1-7. URL:http://print.ispub.com/api/0/ispub-article/5320. Accessed on November 17/11/2015.
7. Fasil Tessema. Under five mortality and its predictors in Gilgel Gibe Health and Demographic Surveillance System Site, South West Ethiopia. Gilgel Gibe Field Research Center Institute of Health Sciences Research Jimma University (Unpublished reporet). 2008. http://www.intrec.info/Training%20material/Block%205/INTREC%20paper%20Fasil%20Tessema.pdf. accessed November 10, 2015.
8. Kembo J, Jeroen K, Ginneken V: Determinants of infant and child mortality in Zimbabwe: Results of multivariate hazard analysis *Demographic Research* 2009, 21(13).
9. Okwaraji YB, Cousens S, Berhane Y, Mulholland K, Edmond K. Effect of Geographical Access to Health Facilities on Child Mortality in Rural Ethiopia: A Community Based Cross Sectional Study. PLoS ONE. 2012. 7(3): e33564. doi:10.1371/journal.pone.0033564.
10. Regassa N: INFANT MORTALITY IN THE RURAL SIDAMA ZONE, SOUTHERN ETHIOPIA: EXAMINING THE CONTRIBUTION OF KEY PREGNANCY AND

POSTNATAL HEALTH CARE SERVICES. *Journal of Nursing, Social Studies, Public Health and Rehabilitation* 2012, 1(2):51–61.

11. World Health Organization: World Health Report 2005: Make every mother and child count. Geneva. http://www.who.int/whr/2005/whr2005_en.pdf. 2005.
12. Islam MM, Azad KMAK: Rural-urban migration and child survival in urban Bangladesh: are the urban migrants and poor disadvantaged? *Journal of biosocial science* 2008, 40(1):83-96.
13. Kyei KA: Determinants of Childhood Mortality in South Africa: Using Categorical Data Modeling. *J Hum Ecol,* 2012, 37(1):47-56.
14. Mondal NI, Kamal Hossain, Korban Ali: Factors Influencing Infant and Child Mortality: A Case Study of Rajshahi District, Bangladesh. *J Hum Ecol,* 2009, 26(1):31-39
15. Uddin J, Zakir H: Predictors of Infant Mortality in a Developing Country. *Asian Journal of Epidemiology* 2008, 1(1):1-16.
16. Caldwell JC: Education as a Factor in Mortality Decline An Examination of Nigerian Data. *Population Studies* 1979, 33(3).
17. Nakamura H, Ikeda N, Stickley A, Mori R, Shibuya K: Achieving MDG 4 in sub-Saharan Africa: what has contributed to the accelerated child mortality decline in Ghana? *PloS one* 2008, 6(3).
18. Economic Policy PaSOE, SPC and Macro International Inc,: Republic of the Marshall Islands Demographic and Health Survey. 2007:112-124.
19. Spatial analysis of risk factors for childhood morbidity in Nigeria [http://wrap.warwick.ac.uk/159/1/WRAP_Kandala_770.pdf]
20. Cleland JG, van Ginneken JK: Maternal education and child survival in developing countries: The search for pathways of influence. *Social science & medicine* 1988, 27(12):1357-1368.
21. Schmeer KK: Married women's resource position and household food expenditures in Cebu, Philippines. *Journal of Marriage and Family* 2005, 67(2):399-409.
22. Mistry R, Galal O, Lu M: "Women's autonomy and pregnancy care in rural India: a contextual analysis". *Social science & medicine (1982)* 2009, 69(6):926-933.
23. Saleem S, Bobak M: Women's autonomy, education and contraception use in Pakistan: a national study. *Reproductive Health* 2005, 2.

24. Kisore S, Parasuraman S: *Mother's Employment and Infant and Child Mortality in India. Mumbai, India and Honolulu. USA: NFHS Subject Report No8 IIPS and East-West Center, Program on Population* 1998.
25. Mosley WH, Chen LC: An analytical framework for the study of child survival in developing countries. 1984. *Bulletin of the World Health Organization* 2003, 81(2):140-145.
26. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions: At Wereda Level from 2014 – 2017. 2013, Addis Ababa, Ethiopia
27. Shifa GT, Ahmed AA, Yalew AW: Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia: A community based study. *BMC pediatrics* 2016, 16(1):30.
28. Yigzaw M, Enquselassie F. Birth Spacing and Risk of Child Mortality at Kalu District South Wollo Zone of Amhara Region, North East Ethiopia. Ethiop Med J. 2010;48(2):105-15.
29. Girma B, Berhane Y: Children who were vaccinated, breast fed and from low parity mothers live longer: A community based case-control study in Jimma, Ethiopia. *BMC Public Health* 2011, 11(1).
30. Kedir Teji, Yadeta Dassie, Nega Assefa, Tesfaye Gobena: Determinants of Infant Mortality in Kersa District, Eastern Ethiopia: A Case Control Study. Presented on World Federation of Public Health, Addis Ababa Ethiopia, 2012. URL:https://wfpha.confex.com/wfpha/2012/webprogram/Paper10261.html.
31. Fantahun M, Berhane Y, Wall S, Byass P, Högberg U: Women's involvement in household decision-making and strengthening social capital crucial factors for child survival in Ethiopia. Acta Paediatr. 2007 April 1; 96(4): 582–589.
32. Eshetu Gurmu, Akim Mturi. Trends and Determinants of Infant and Child Mortality in Ethiopia: Could the MDG four be met? Southern African Journal of Demography. 2014. 15(1):49-80
33. Greenaway ES, Leon J, Baker DP: Understanding the association between maternal education and use of health services in Ghana: exploring the role of health knowledge. *J Biosoc Sci* 2012, 44(6):733-747.

34. Biks GA, Berhane Y, Worku A, Gete YK: Exclusive breast feeding is the strongest predictor of infant survival in Northwest Ethiopia: a longitudinal study. Journal of Health, Population and Nutrition (2015) 34:9. DOI 10.1186/s41043-015-0007-z.
35. Engle PL, Bentley M, Pelto G: The role of care in nutrition programmes: current research and a research agenda. *The Proceedings of the Nutrition Society* 2000, 59(1):25-35.
36. Castle SE: Intra-household differentials in women's status: household function and focus as determinants of children's illness management and care in rural Mali. *Health transition review: the cultural, social, and behavioural determinants of health* 1993, 3(2):137-157.
37. Fikree FF, Pasha O: Role of gender in health disparity: the South Asian context. *BMJ : British Medical Journal* 2004, 328(7443):823-826.
38. World Health Organization: Indoor air pollution, health and the burden of diseas: Indoor air thematic breafing 2. URL: http://www.who.int/indoorair/info/briefing2.pdf. Accessed: September 3, 2015
39. Bruce NG, Dherani MK, Das JK, Balakrishnan K, Adair-Rohani H, Bhutta ZA, Pope D: Control of household air pollution for child survival: estimates for intervention impacts. *BMC Public Health* 2013, 13 Suppl 3:S8.
40. Upadhyay AK, Singh A, Kumar K, Singh A: Impact of indoor air pollution from the use of solid fuels on the incidence of life threatening respiratory illnesses in children in India. *BMC Public Health* 2015, 15:300.
41. Hossain M, Islam M. Effects Of Demographic And Household Variables On Infant And Child Under-five Mortality: An Application Of Logistic Model. The Internet Journal of Health. 2008, 8(2).
42. Checkley W, Epstein LD, Gilman RH, Cabrera L, Black RE: Effects of acute diarrhea on linear growth in Peruvian children. *American journal of epidemiology* 2003, 157(2):166-175.
43. Lorntz B, Soares AM, Moore SR, Pinkerton R, Gansneder B, Bovbjerg VE, Guyatt H, Lima AM, Guerrant RL: Early childhood diarrhea predicts impaired school performance. *The Pediatric infectious disease journal* 2006, 25(6):513-520.

Table 1: Socioeconomic-demographic characteristics of the participants, Gamo Gofa Zone, 2014

Characteristics		Survival status of the child		Total n(%)
		Dead n(%)	Alive n(%)	
Sex of the child	Male	210(55.1)	382(50.1)	592(51.8)
	Female	171(44.9)	380(49.9)	551(48.2)
Maternal age	<18year	7(1.8)	12(1.6)	19(1.7)
	18-35year	332(87.1)	688(90.3)	1020(89.2)
	>35year	42(11.0)	62(8.1)	104(9.1)
Mother Religion	protestant	251(65.9)	517(67.8)	768(67.2)
	orthodox	115(30.2)	216(28.3)	331(29.0)
	others	15(3.9)	29(3.8)	44(3.8)
Mother education	No formal education	210(55.1)	362(47.5)	572(50.0)
	Grade1-6	106(27.8)	188(24.7)	294(25.7)
	Grade7-8	25(6.6)	80(10.5)	105(9.2)
	Grade 9 and above	40(10.5)	132(17.3)	172(15.0)
Mother ethnicity	Gamo	286(75.1)	571(74.9)	857(75.0)
	Gofa	8(2.1)	20(2.6)	28(2.4)
	Wolayta	26(6.8)	52(6.8)	78(6.8)
	Zeyse	37(9.7)	78(10.2)	115(10.1)
	Amhara	6(1.6)	19(2.5)	25(2.2)
	Others	18(4.7)	22(2.9)	40(3.5)
Mother Occupation	Farmer	22(5.8)	35(4.6)	57(5.0)
	House wife	264(69.3)	539(70.7)	803(70.3)
	Gov't employee	14(3.7)	36(4.7)	50(4.4)
	Merchant	36(9.4)	84(11.0)	120(10.5)
	Others	45(11.8)	68(8.9)	113(9.9)
Marital status	Married	358(94.0)	731(95.9)	1089(95.3)
	Single	11(2.9)	21(2.8)	32(2.8)
	Others	12(3.1)	10(1.3)	22(1.9)
Husband occupation	Farmer	190(50.1)	433(56.8)	623(54.5)
	Gov't or NGO employee	34(8.9)	96(12.6)	130(11.4)
	Merchant or self-employee	33(8.7)	73(9.6)	106(9.3)
	Daily laborer	66(17.3)	61(8.0)	127(11.1)
	Student	6(1.6)	15(2.0)	21(1.8)
	Others	29(7.6)	53(7.0)	82(7.2)
	No husband	23(6.0)	31(4.1)	54(4.7)
Husband Education	No formal education	133(37.2)	228(31.2)	361(33.1)
	Grade1-6	121(33.8)	201(27.5)	322(29.6)
	Grade7-8	35(9.8)	98(13.4)	133(12.2)
	Grade9-12	36(10.1)	122(16.7)	158(14.5)
	Higher education	33(9.2)	82(11.2)	115(10.6)
Wealth index of the household	Poor	159(41.7)	298(39.1)	457(40.0)
	Average	98(25.7)	136(17.8)	234(20.5)
	Rich	124(32.5)	328(43.0)	452(39.5)

Table 2: Association of Socio-economic characteristics (distal factors) with child mortality, Gamo Gofa Zone, 2014

		Under-five*			Infants*		
Characteristics	**Categories**	**AOR**	**[95% Conf. Interval**		**AOR**	**[95% Conf. Interval**	
Sex of the child	Male	Ref					
	Female	0.76	0.57	1.02	0.75	0.52	1.08
Mother's religion	Protestant						
	Orthodox	1.27	0.86	1.87	1.10	0.67	1.79
	Others	1.18	0.53	2.67	1.40	0.41	4.71
Mother's Ethnicity	Gamo	Ref					
	Zeyse	1.09	0.37	3.17	0.62	0.14	2.82
	Wolayta	1.07	0.48	2.40	0.66	0.25	1.76
	Others	1.66	0.87	3.18	1.37	0.63	2.98
Mother's education	No formal education	Ref					
	Grade1-6	0.94	0.63	1.43	0.97	0.57	1.65
	Grade7-8	0.68	0.35	1.31	0.69	0.31	1.56
	Grade 9 and above	**0.33**	**0.16**	**0.72**	**0.36**	**0.15**	**0.91**
Mother's Occupation	Farmer	Ref					
	House Wife	0.70	0.32	1.52	0.59	0.25	1.38
	Gov't employee	0.57	0.12	2.74	0.80	0.14	4.61
	Merchant	0.50	0.20	1.28	0.43	0.15	1.27
	Others	1.31	0.44	3.91	1.10	0.33	3.66
Marital status	Married	Ref					
	Single	1.22	0.42	3.54	0.49	0.10	2.30
	Others	**3.59**	**1.23**	**10.47**	**6.68**	**1.81**	**24.71**
Husband occupation	Farmer	Ref					
	Gov't employee	0.69	0.31	1.55	0.78	0.30	2.03
	Merchant	1.84	0.92	3.66	1.43	0.66	3.08
	Daily laborer	**2.34**	**1.29**	**4.23**	1.79	0.86	3.74
	Student	1.26	0.41	3.84	1.47	0.32	6.77
	Others	1.67	0.86	3.24	1.54	0.69	3.44
Wealth index of Household	Rich	Ref					
	Average	1.49	0.85	2.62	1.51	0.74	3.07
	Poor	1.52	0.93	2.48	1.75	0.97	3.16
Number of individuals living in the house		0.94	0.87	1.03	0.93	0.83	1.03
Maternal power	Poor	Ref					
	Average	1.48	0.69	3.19	1.88	0.80	4.44
	Good	0.91	0.65	1.28	0.89	0.57	1.38

*Adjusted for all variables in the table

Table 3: Association between environmental contamination factors & under-five mortality, Gamo Gofa Zone, 2014

	Under-five*			Infants**		
Characteristics	**AOR**	**[95% Conf. Interval]**		**AOR**	**[95% Conf. Interval]**	
The house has window						
Yes	RF					
No	0.74	0.45	1.23	0.75	0.40	1.40
Did animals live with people						
Yes	Ref					
No	1.17	0.72	1.92	1.07	0.60	1.90
Had kitchen						
Yes	Ref					
No	**1.77**	**1.16**	**2.70**	**1.94**	**1.13**	**3.33**
Type of latrine the family had						
No latrine	Ref					
Pit latrine	1.03	0.60	1.76	1.04	0.51	2.11
VIP/Flush	1.37	0.50	3.73	1.04	0.30	3.65
Main source of water						
Tap	Ref					
Protected well/spring	0.92	0.51	1.66	1.48	0.69	3.20
Unprotected well/spring/river/pond	1.02	0.61	1.72	1.26	0.63	2.52
Source of light of the household						
Other than electricity	Ref					
Electricity	0.87	0.48	1.57	**0.47**	**0.22**	**0.99**

*Besides variables in the table adjusted for sex of the child, mother's education, wealth index, husband occupation and marital status of the mother

** Besides the variables in the table adjusted for sex of the child, mother's education, wealth index and marital status of the mother

Paper (Manuscript) III- Maternal &child characteristics, practices & health interventions that affect childhood mortality

Maternal and child characteristics, practices and health interventions that affect childhood mortality: the case of Gamo Gofa Zone, Southern Ethiopia

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Abstract

Background: Though Ethiopia has shown a considerable improvement in reducing childhood mortality since 1990, many children still continue to die prematurely because of different factors and causes. Mixed results have been reported about determinants of childhood mortality. There is paucity of under-five mortality studies in the current study site. Therefore, this study was conducted to assess maternal and child health related predictors of under-five mortality in Gamo Gofa Zone, Southern Ethiopia.

Methods: A matched case control study was conducted in 2014 in Arba Minch town and Arba Minch Zuria District of Gamo Gofa Zone by including study sites of Arba Minch Demographic and Surveillance System (DSS). Conditional logistic regression was employed to identify maternal and child health related predictors of under-five mortality. Sampling weight was used in the analysis to account for the non-proportional allocation of sample to different clusters. The predictors were organized in to: personal illness control related, child feeding and newborn care related and other maternal and child related, based on the Mosley & Chen's analytical framework for the study of determinants of childhood mortality.

Results: Among personal illness control related factors, lack of post natal care (AOR of 2.27(1.25-4.11)), immunization status of the child (AOR of 3.62(2.02-6.50) for partially immunized and AOR of 11.02(5.16-23.53) for not immunized compared with fully immunized) and lack of vitamin A at least once after six months of age (AOR of 7.61(4.72-12.26)) were significantly associated with higher rate of under-five mortality. Among factors related with child feeding and newborn care practices, lack of breast feeding (AOR of 8.09(4.08-16.05)) and delaying first bath at least for 24 hours (AOR of 0.50(0.34-0.73)) were found to be significantly associated with under-five mortality. Among other maternal and child related factors, previous birth interval of 24-36months (AOR of 0.48(0.28-0.82) and more than 36 months (AOR of 0.46(0.26-0.79)), history of death of older sibling of the index child (AOR of 1.97(1.07-3.61)), being multiple birth (AOR of 13.72(5.26-35.79)) and live birth after the index child (AOR of 5.06(2.80-9.16)) were significantly associated with under-five mortality.

Conclusions: In order to maintain reduction of childhood mortality beyond millennium development goals (MDGs) period, strengthening of maternal and child health interventions such

as post natal care, family planning, immunization, supplementation of vitamin A for children older than six months, breastfeeding and delaying of first bath after delivery at least for 24 hours were recommended.

Key words: Under-five mortality, infant mortality, childhood mortality, determinants, health service, maternal characteristics, child characteristics, new born care, Gamo Gofa, Ethiopia

Background

Many children are thought to be dying owing to untrained traditional birth attendants, relatives and neighbors who attend most of deliveries at home [1], a practice that may present risk to both the mother and the newborn. Even though some were skeptical of the association between the use of maternal and child health services and lower risk of mortality in developing countries, partly because of lack of quality [2, 3], many studies support the positive association between service use and maternal and child survival. For example, it is evident from studies [4, 5] that survival is higher among children born in health facilities than those born at home and attended by untrained attendants, with higher effect on older children [5]. Place of delivery is also found to be associated with early childhood illness such as neonatal tetanus [6]. However, protective effect of institutional delivery on childhood mortality was not demonstrated by other studies conducted in Ethiopia [7, 8]. It is possible to argue that, this lack of association could be as a result of limited quality of health services.

With the hope that pre-natal care improves maternal and child survival, the World Health Organization (WHO) recommends that a pregnant mother should have at least four prenatal visits during her pregnancy [9]. This was supported by studies, that utilization of antenatal (ANC) care services were shown to significantly determine survival of children [4, 10]. However, effects of ANC and institutional delivery services are expected to be context dependent based on the level of quality of services being provided.

Immunization may be one of the effective child-survival interventions to date as it addresses diseases which contribute significantly to high childhood mortality including neonatal tetanus, whooping cough, polio and measles. Immunization status of a child was shown to be an important factor of childhood survival [5]. However, such conclusions were not made by other studies [11, 12], that immunization status was reported to have insignificant effect on childhood mortality. In addition, the effect was shown to be higher in communities with low socioeconomic status [13], indicating its effect is context dependent.

In addition to immunization, vitamin A supplementation is one of the health interventions which are expected to have many health benefits for children. Vitamin A status of children aged six months to five years was shown to be important predictor of mortality [14, 15]. The effect was

significant, especially in populations with low prevalence of clinical signs of vitamin A deficiency [15]. As vitamin A was shown to significantly reduce deaths attributed to diarrhea and measles [14, 15], it is natural to expect that, the effect is dependent on the prevalence of these causes of mortality. Insignificant association between vitamin A and childhood mortality was also observed by another study [16].

Promotion of breast feeding is considered to be a key component of child survival strategies in many developing countries [17]. Accordingly, WHO and other international policies emphasize on exclusive breast feeding during the first six months of life, early initiation of breast feeding within one hour of birth and continuation of breast feed with other complementary feedings till 2nd birth day of the child [18, 19]. As exclusive breast feeding was reported to be associated with intermediate causes of childhood mortality such as diarrhea and respiratory infections [20, 21], its effect on childhood mortality may vary based on the prevalence of these intermediate causes. Besides, the extent of the effect of breast feeding on child mortality also varies across the age category of the child, with younger infants deriving the greatest benefit [22]. There are findings, however, which are inconsistent with the above conclusions, showing insignificant association between child mortality and breast feeding [23]. Besides, problems with breast feeding, which are a proxy indicator of exclusive breast feeding, were not shown to have significant effect on childhood mortality in Africa [12, 24].

The WHO guidelines for essential newborn care include: hygiene during delivery, keeping the newborn warm, early initiation of breast feeding, care of the eyes, care during illness, immunization, and care of low-birth-weight newborns [25]. However, majority of deliveries in developing countries in general and in Ethiopia in particular take place at home by untrained birth attendants [1]. As a result, many lifesaving practices are either missed or done in unwanted manner, consequently high risk home delivery and newborn care practices become more common. The effect of these interventions, however, is expected to be dependent on how they are brought to the users.

Other maternal and child characteristics have also been studied and attributed to child and maternal mortalities. For example, mothers with short birth intervals may have insufficient time to restore their nutritional reserves, a situation which is thought to adversely affect fetal growth. As a result,

WHO recommends at least 24 months of spacing between a preceding birth and a new pregnancy [26]. This was supported by other studies [27, 28]. However, it is argued that, short birth intervals can be a consequence, rather than a cause of child mortality [29], i.e., parents with child loss are more likely to have next child immediately than those with alive child.

According to the hypothesis of intra-household resource competition, first born children are more likely to capture vital resources such as food and care, thereby reducing their mortality risk [30] and this idea has also been supported by others [28, 31]. On the other hand, it can be argued that first born children are more likely to be born to mothers at younger ages and experience a higher mortality risk. Insignificant association between child mortality and birth order was also reported by another study too [23].

Besides the inconsistencies in findings of studies outlined above, the effect of different maternal and child related factors on childhood mortality may vary through time because of changes in the life style of nations. Furthermore, the associations may be context dependent. Mortality studies in the study site have been lacking, as the Arba Minch DSS is relatively new. All these call for investigation of determinant factors in general and maternal and child related factors in particular of under-five mortality in the study area. Therefore, this study investigated maternal and child related predictors of under-five mortality in Gamo Gofa Zone, southern Ethiopia. The study tried to identify maternal and child health related areas to be focused on in order to sustain reduction of childhood mortality and improve child survival beyond Millennium Development Goals (MDGs) and attainment of SDG targets.

Methods

Study area: The study was conducted in Arba Minch Zuria District and Arba Minch Town of Gamo Gofa Zone, which has 15 Districts (woredas) and 2 town administrations with general elevation of 600 to 3300 meters above sea level. The Zone is 502km south of Addis Ababa (capital of the country). In 2014, the total population of the Zone was projected to be 1,901,953 (with 285,043 Urban (15%) and 1,616,910 Rural (85%) residents)[32]. There were three hospitals and 68 health centers providing health services for the population during the study period. Arba Minch Zuria District has 29 kebeles (lowest administrative units in Ethiopia) with three different climatic/agro-ecological zones (high land (Dega), mid land (Weinadeaga) and low land (Kola)). The total population of the District was projected to be 185,302 in 2014. Arba Minch Town is included to represent the urban population of the Zone. The total population of the Town was projected to be 135,452 [32]. The Town was divided in to 11 urban kebeles. Arba Minch DSS was established in 2009 in nine kebeles of the Arba Minch Zuria District. Further details of the study area are presented elsewhere [33].

Study Design and Period: A matched case control study design was implemented in 2014.

Source and study population: The source population was all under-five children in the study area. The study population consisted of cases of children who died between March 01, 2011 and September 30, 2014 and randomly selected two live controls of under-five children born within one month time in the same locality with each case.

Inclusion and exclusion criteria: Only live births were included i.e. stillbirths were excluded.

Sample size determination: The sample size was calculated using statcalc command of Epi info 7 statistical software package. The prevalence of exposure (selected determinants) among controls and cases were estimated from previous studies [7, 8, 34-37] or calculated from the data available from Arba Minch DSS's Data base. Then, the sample size required for detecting an odds ratio (OR) with a two-sided probability of type I error of 5% and a power of 80% was determined for main exposure variables with control to case ratio of two. Then, the maximum sample size was taken. Accordingly, based on the sample size corresponding to home delivery, a minimum of 241 cases and 482 controls were required. By applying a design effect of 1.5 and adding 5% to compensate for non-response, a total of 380 cases and 760 controls were required. The details of

the estimations, indicators and sample size required for selected variables are summarized in table1.

Sampling technique: Arba Minch Town and the Arba Minch Zuria District have been purposively selected. Then, all 11 kebeles of Arba Minch Town and nine kebeles of the Arba Minch DSS (initially they were selected randomly out of 29 kebeles of Arba Minch Zuria District) were taken and additional 11 kebeles from Arba Minch Zuria District were randomly selected. Then, a census of the 11 non- DSS kebeles of the Arba Minch Zuria District and 11 kebeles of Arba Minch Town was conducted. As the Arba Minch DSS has been tracking all births and deaths since its establishment, children born between August 01, 2009 and September 30, 2014 in Arba Minch DSS kebeles were tracked from its data base. A further detail of this part is presented elsewhere [33]. From the census and the Arba Minch DSS, 383 cases that fulfilled the inclusion criteria were identified. And all of them with their corresponding matched and randomly selected 766 controls were approached. However, data only from 381 cases and 762 controls were obtained. Data from two cases and their corresponding controls were not retrieved from two kebeles since they migrated out from their initial location.

Data collection: A pre-tested close ended structured Amharic questionnaire was utilized for data collection. The questionnaire was developed in English based on literatures and translated in to Amharic, then back translated to English to ensure for its consistency. Finally, the Amharic version was used for data collection. Two data collectors (at least certificate holders after completing grade 10) per kebele were recruited and trained on the procedure. Four supervisors who were master's degree holder supervised the data collection process. The principal investigator strictly followed the data collection process.

Measurements

Dependent variable: Mortality status (dead or alive) of the index child

Independent variables: Socio economic-demographic characteristics, personal illness control related variables, child feeding and newborn care related variables and other maternal and child related variables.

Data processing and management: The data were edited, coded, entered into computer and

cleaned using Epi Info Version 3.5.1. The analysis was performed by STATA version 11. The data were entered into Epi info by two data encoders after having training /orientation. Data entry was strictly followed and checked by the principal investigator on daily basis. Double entry of 10% of the questionnaires was made.

Data analysis: To identify maternal and child health related predictors of under-five mortality, conditional logistic regression was conducted. Sampling weight was employed in the analysis to account for the non-proportional allocation of the sample. The sampling weight was taken as the reciprocal of probabilities of selection. The probability of selection for urban was = 1/2*1*306/5745= 0.027 (as one out of 2 urban Districts and all the kebeles in selected District were included. Three hundred six out of 5745 children identified by the census were included). The corresponding sampling weight for urban was calculated to be 37.6. For that of rural=1/15*20/29*837/14416=0.0027(as one out of 15 rural Districts, twenty out of 29 kebeles of the District were included and 837 out of 14416 children identified were included in the study). The corresponding sampling weight for rural was calculated to be 374.6.

The models were fitted based on Mosley & Chen's analytical framework for the study of determinants of child mortality [38]. Accordingly, three separate models were fitted for personal illness control related variables, child feeding and newborn related variables and maternal and child related variables by controlling distal factors (socioeconomic variables) which were significant at p-value of 0.1. Sex of the child was also included in all models, as it was found to be significantly associated with childhood mortality in previous paper [33]. Model diagnostic was conducted following each model using different STATA commands: For example, presence of specification error in the link term (logistic) or predictors was assessed with linktest command. Besides, the goodness of fit of the models was assessed by log likelihood chi-square test of the null hypothesis of no overall effect of predictors (comparing empty model with current model) on the outcome and Akaike Information Criterion (AIC) using estat ic command. Presence of interaction/effect modification was also assessed for suspected variables. No significant interaction/ effect modification was observed. Collin command was used to assess presence of multicollinearity among predictors. Tolerance value <=0.1 or variance inflation factor (VIF) of greater than or equal to 10 were taken as an indicator of presence of multicollinearity. No multicollinearity was identified as all VIF were less than 5.

Result

Data from 381 cases and 762 controls were retrieved giving a response rate of 100%. Majority 837(73.2) of the children were from rural kebeles. Slightly more than half 210(55.1%) of the cases and 382(50.1%) of the controls were males. With regard to maternal education, more than half 210(55.1%) of the cases and less than half 362(47.5%) of the controls had no formal education. Pertaining to ethnic background, majority of mothers of the cases 286(75.1%) and the controls 571(74.9%) were Gamo. Most mothers of the cases 264(69.3%) and controls 539(70.7%) were housewives. Nearly half of husbands of the cases 191(50.1%) and controls 433(56.8%) were farmers. Using wealth index, 124(32.5%) of the cases and 328(43.0%) of the controls were classified as rich. Majority of the cases 262(68.8%) and controls 492(64.6%) were born at home. The details of the socio-demographic characteristics of the study participants were presented elsewhere (Girma Temam Shifa et al. unpublished article).

Association between personal illness control related factors and childhood mortality

Among factors classified as personal illness control; post natal care (PNC) for the index pregnancy/child, antenatal care (ANC) for the index pregnancy, immunization status of the child for his /her age and whether the child had vitamin A or not were significantly associated with under-five and/or infant mortality (Table 2).

The odds of mortality was about two times higher among under-five children who lacked PNC (AOR of 2.27(1.25-4.11)) than those who had. Similarly, lack of PNC service was shown to increase the odds of mortality by about 2 folds during the first year of life of the child (AOR of 2.35(1.02-5.45)). Infants who had at least four ANC follow-up during their pregnancy had less odds of mortality (AOR of 0.45(0.23-0.90)) than those infants who lacked ANC. Though it is not significant, similar effect was observed among under-five children with AOR of 0.72(0.42-1.24) (Table 2).

The odds of mortality among under-five children who were partially immunized for their age, was about four times higher (AOR of 3.62(2.02-6.50)) than those fully immunized. The odds of mortality among under-five children, who were not immunized at all, was about 11 times higher (AOR of 11.02(5.16-23.53)) than children who were fully immunized for their age. Similarly, significant increment of odds of mortality was observed among partially (AOR of 4.10(1.81-

9.30)) and not immunized (AOR of 18.54(6.22-55.26)) infants than fully immunized infants (Table 2).

Under-five children who didn't take vitamin A at least once after six months of their age had about 8 times (AOR of 7.61(4.72-12.26)) higher odds of mortality than those who did. Similarly, lack of vitamin A was shown to increase odds of mortality during the first year of age of the child (AOR of 15.29(6.38-36.65)). In this study, place or attendants of delivery of index child were not significantly associated with under-five mortality (Table 2).

Association between child feeding and newborn care practices and childhood mortality

Among factors related with child feeding and newborn care practices: history of ever breastfeeding and timing of first bath of the index child were significantly associated with under-five mortality. Under-five children who were never breastfed had about 8 times (AOR of 8.09(4.08-16.05)) higher rate of odds of mortality than those who were ever breastfed. Similarly, those infants who were never breastfed had higher rate of odds of mortality (AOR of 14.19(5.51-36.50)) than those who were ever breastfed. Delaying first bath of a child at least to 24 hours after birth was shown to reduce odds of under-five mortality by 50% (AOR of 0.50(0.34-0.73)) and odds of infant mortality by 54% (AOR of 0.46(0.28-0.77)) than having first bath within 24 hours of birth (table 3).

Although the associations were in expected direction, the association between under-five and/or infant mortality and factors like exclusive breast feeding status of the child, history of bottle feeding, breastfeeding initiation time and history of something applied to the umbilical wound were not significant (table 3).

Association between other maternal and child related factors and childhood mortality

Among other maternal and child related factors included in model 3 (table 4); birth interval, history of child death before the index child, type of birth of index child and presence of live birth after index child were significantly associated with under-five and infant mortality. Under- five children who had birth interval of 24-36months (AOR of 0.48(0.28-0.82)) or more than 36 months (AOR of 0.46(0.26-0.79)) had less odds of mortality than those children who had birth interval of less than 24months. Similarly, infants who had birth interval of 24-36months (AOR of

0.28 (0.14-0.54)) or more than 36 months (AOR of 0.29 (0.15-0.55)) had less odds of mortality than infants who had birth interval of less than 24months (table 4).

Under-five children (AOR of 1.97(1.07-3.61)) and infants (AOR of 3.37 (1.51-7.50)) with history of death of older siblings had higher rate of odds of mortality than those without history of death of older siblings (table 4).

Those under-five children whose births were multiple had higher rate of odds of mortality (AOR of 13.72(5.26-35.79)) than those who were single birth. Similar effect was observed among infants (AOR of 21.18 (5.85-76.74)). Under-five children of mothers with history of birth after the index child had a higher rate of mortality (AOR of 5.06(2.80-9.16)) than those without. However, age of mothers at child birth, gravidity and birth order of index child were not significantly associated with under-five mortality in this study (table 4).

Discussion

This study has identified vital maternal and child health related predictors of under-five mortality by controlling for effects of potential confounders at design and analysis stage. For this purpose, efforts such as matching at design stage and weighted conditional logistic regression during analysis were employed. However, as the information was collected retrospectively systematic errors such as recall bias may affect some of responses.

Both mothers and their newborns are vulnerable during the postnatal period and provision of PNC services at this period is expected to prevent maternal and child morbidity and mortality [39, 40]. This time is crucial not only to treat complications arising from the delivery, but also to provide the woman with important information on how to care for herself and her child. In support of this, in the current study, lack of PNC was found to increase the odds of mortality by about 2.3 folds during the first five years of age and by about 2.4 folds during the first year of age of the child. This finding is also in line with another study [41], which analyzed Demographic and Health Survey data from sub-Saharan African countries.

Infants who had at least four ANC follow-up during their pregnancy had less odds of mortality than those infants who lacked ANC. Though it was not significant, similar effect was observed among under-five children. Even though it was not statistically significant, experience of even less than four ANC follow ups during pregnancy of the index child was shown to reduce odds of under-five and infant mortality. Similar protective effect of ANC follow up was observed by other studies [4, 10]. This may be because of the criticality of this time for the mother and the fetus that, it helps to identify high risk pregnancy including multiple pregnancy (which was shown to be a risk factor in this study) in order to take appropriate actions.

In contrast to reports of other studies in the past [4, 5] about positive effect of institutional or skilled attendance of delivery on childhood mortality, place and attendance of delivery of the index child were not significantly associated with under-five mortality in the current study. Nevertheless, institutional delivery did not show a protective effect in other studies conduct in Ethiopia [7, 8]. Lack of significant association between delivery at hospital or skilled attendant and neonatal mortality was also reported by another study [42]. This may be due to the fact that complicated cases were more likely to come for institutional delivery than to stay at home.

However, health service delivery systems in developing countries are criticized for failing to bring the expected health benefits at expected level, partly because of dysfunctional health services [2, 3]. So, these findings could be motivating factors to question and investigate the quality of delivery services provided by health facilities in the study areas.

Immunization is the most effective child-survival intervention to date and the immunization status of children was reported to be an important factor of survival [5] with its greater impact in communities with low socioeconomic status [13]. Similarly, in the current study, immunization status for age of the child was significantly associated with under-five and infant mortality. The odds of mortality of under-five children were, about 3.6 times if they were partially immunized and about 11 times if they were not immunized at all, compared to those fully immunized. Similar to immunization status, the odds of under-five and infant mortality were high among children who lacked vitamin A supplementation at least once after six months of their age than those who took. Vitamin A supplementation is another child health intervention and reported to reduce childhood mortality attributed to diarrhea and measles [14, 15]. Both the above findings ratify the importance of strengthening of these interventions for sustenance of the reduction of childhood mortality beyond the MDGs.

Among factors related to child feeding and newborn care practices, history of ever breast feeding was found to be significantly associated with low under-five and infant mortality. Breast feeding has been reported to be a major determinant of child health and mortality [37, 43]. As a result, the promotion of breast feeding is considered to be a key component of child survival strategies in many developing countries [17]. Even though, because of the design of this study, the problem of residual reverse causality couldn't be ruled out, the finding of this study support the promotion of breastfeeding as a strategy for better child survival in developing countries like Ethiopia.

In this study, exclusive breast feeding status of the child and history of bottle feeding were not significantly associated with under-five mortality. This was in line with the finding of another study [44]. Insignificant difference of mortality among exclusively breast fed children and predominantly breast fed children was also reported by another study [43]. Problem of breast feeding which may be a proxy indicator of lack of exclusive breastfeeding was also not associated with childhood mortality by another study [45]. The lack of significant association in the current

study may be because of rareness of these practices in the study area, as exclusive breast feeding is not widely practiced, that only 32% of Ethiopian infants 4-5 months were reported to be exclusively breast fed [1]. Delaying first bath of a child at least to 24 hours after birth was shown to reduce odds of under-five and infant mortality. This finding strengthens the importance of the WHO recommendation of delaying first bath of a child after 24 hours [46] and it needs to be strengthened as one of the strategies for newborn thermal care at delivery.

Among other maternal and child related factors, previous birth interval was significantly associated with both under-five and infant mortality. Children who had longer birth intervals had less odds of mortality than those children who had birth interval of less than 24months. Studies in developing countries also showed inverse association between the length of preceding birth interval and childhood mortality [7, 27, 28,47]. This may be because of maternal depletion, as women with short intervals between two pregnancies may have insufficient time to restore their nutritional reserves, a situation which is thought to adversely affect fetal growth, resulting in a low birth weight or small for gestation [26], which are shown to have a negative effect on child survival [42]. Competition for resources among the siblings may be another explanation for the association. Therefore, this finding strengthens the importance of WHO's recommendation of at least 24 months spacing [26] by advocating and strengthening family planning methods.

History of death of older siblings of the index child was shown to significantly increase the odds of mortality among under-five children and infants. Similarly, higher risk of childhood mortality was reported among children who had death of an older sibling by other studies [47-50]. This may be because of the fact that, the factors responsible for the death of previous child sustain and result in the death of the index child.

Multiple births are relatively rare events compared to singleton births, but reported to be a risk factor for childhood mortality particularly in resource limited settings [47, 51-53]. Similarly, in the current study, those under-five children whose births were multiple had higher rate of odds of mortality than those who were single births. Similar effect was observed among infants. So, these findings indicate the importance of meticulous identification and investigation of high risk pregnancies, including multiple pregnancies, during prenatal period in order to take appropriate action.

History of live birth after the index child was examined only for under-five mortality in order to account for the time required to give birth after birth of the index child. And it was significantly associated with under-five mortality that, under-five children of mothers with history of birth after the index child had higher rate of odds of mortality than those without. This may be because of resource competition for feeding and care. However, birth after index child may be a consequence to replace the dead child rather than a cause of child mortality.

Conclusions and recommendation

Among factors classified as personal illness control, having at least four ANC follow-up during pregnancy, utilization of PNC, immunization status of the child and supplementation of vitamin A for children older than six months were significantly associated with childhood mortalities. Therefore, these interventions should be strengthened and continued as strategies of child survival interventions to maintain reduction of childhood mortalities beyond MDGs.

Similar to other studies conducted in the country, the current study showed insignificant association between child hood mortality and place and attendants of delivery. So, these findings may be an alert to question and investigate the quality of delivery services being provided by health facilities in the study area in order to extract the expected positive effects of these health services. As delaying first bath of a child at least to 24 hour after birth was shown to reduce odds of childhood mortality, its advocacy and strengthening it as one of the strategies of a newborn thermal care at delivery is crucial.

Previous birth interval was among maternal and child factors which was significantly associated with under-five mortality. Besides, birth after index child was shown to increase odds of mortality among under-five children. So, advocacy of family planning to delay inter-birth intervals at least to 24 months may be crucial not only for subsequent birth, but also for the older children.

Children whose birth was multiple births had higher rate of odds of mortality than those who were single birth. Meticulous identification and investigation of high risk pregnancies, including multiple pregnancies, during prenatal period in order to minimize the negative effect of such risk factors is important.

Declarations

Ethical considerations*:* Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Letters were written to all concerned bodies and permissions were secured at all levels. After explaining about the purpose of the study and confidentiality of the data, informed consent was obtained from each respondent. To assure the confidentiality of the responses, anonymous interviews were conducted. Besides, the daily collected data were transferred to Arba Minch University compound and locked in a secure cabinet on daily basis.

Consent to publish: Not applicable as only summary results have been presented in the manuscript

Competing interests: The authors declare that they have no competing interests.

Authors' contributions: Conceived and designed the study: GTS AAA AWY. Conducted the study: GTS AAA AWY. Analyzed the data: GTS AAA AWY. Wrote the paper: GTS AAA AWY. Read the final manuscript and approved for submission: GTS AAA AWY.

Availability of Data and Materials: The data supporting this publication are summarized with tables and figure in the manuscript. However, if the raw data is required, it can be accessed from the authors whenever required using appropriate procedure and format.

List of abbreviations

ANC: Antenatal care
AOR: Adjusted Odds Ratio
DSS: Demographic surveillance site
MDGs: Millennium development
goals PNC: Post Natal Care
WHO: World Health Organization

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References

1. Ethiopia Demographic and Health Survey: Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ORC Macro 2011. 2011.
2. Ruger JP, Kim HJ: Global health inequalities: an international comparison. *Journal of epidemiology and community health* 2006, 60(11):928-936.
3. Huicho L, Davila M, Gonzales F, Drasbek C, Bryce J, Victora CG: Implementation of the Integrated Management of Childhood Illness strategy in Peru and its association with health indicators: an ecological analysis. *Health Policy Plan* 2005, 20 Suppl 1:i32-i41.
4. Malqvist M: Neonatal mortality: an invisible and marginalised trauma. *Global health action* 2011, 4:doi: 10.3402/gha.v3404i3400.5724.
5. Mondal NI, Kamal Hossain, Korban Ali: Factors Influencing Infant and Child Mortality: A Case Study of Rajshahi District, Bangladesh. *J Hum Ecol,* 2009, 26(1):31-39
6. Raza S, Akhtar S, Avan B, Hamza H, Rahbar M: A matched case-control study of risk factors for neonatal tetanus in Karachi, Pakistan. *Journal of Postgraduate Medicine* 2004, 50(4):247-251.
7. Yigzaw M, Enquselassie F. Birth Spacing and Risk of Child Mortality at Kalu District South Wollo Zone of Amhara Region, North East Ethiopia. Ethiop Med J. 2010;48(2):105-15.
8. Regassa N: INFANT MORTALITY IN THE RURAL SIDAMA ZONE, SOUTHERN ETHIOPIA: EXAMINING THE CONTRIBUTION OF KEY PREGNANCY AND POSTNATAL HEALTH CARE SERVICES. *Journal of Nursing, Social Studies, Public Health and Rehabilitation* 2012, 1(2):51–61.
9. Berg C: Prenatal Care in Developing Countries. The World Health Organization Technical Working Group on Antenatal Care. *Journal of the American Medical Women's Association* 1995, 50(5):182-186.
10. Antai D: Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants. *Population Health Metrics* 2011, 9(6):DOI: 10.1186/1478-7954-1189-1186.
11. *Cornelia Kaldewei*: Determinants of Infant and Under-Five Mortality - The Case of Jordan. *Technical note, February 2010*.
12. Ogbe JO: Exclusive Breast Feeding and Children Immunization as Demographic Determinants of Child Mortality in Delta State. . *Pakistan Journal of Nutrition* 2008, 7(1):35-39.
13. Golam AM, Kaniz T, Nafisa K, Kanti BS, Kumar DU: Infant Mortality Situation in Bangladesh in 2007: A District Level Analysis. In: *Centre for Policy Dialogue URL: https://mpraubuni-muenchende/21102/ Accessed on March 02, 2016.* 2010.
14. Beaton GH, Martorell R, Aronson KJ, Edmonston B, McCabe G, Ross AC, Harvey B: Effectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries − Nutrition policy discussion paper No. 13. *URL: http://wwwunscnorg/layout/modules/resources/files/Policy_paper_No_13pdf Accessed on Feb 20, 2016* 1993.
15. Mayo-Wilson E, Imdad A, Herzer K, Yakoob MY, Bhutta ZA: Vitamin A supplements for preventing mortality, illness, and blindness in children aged under 5: systematic review and meta-analysis. *BMJ : British Medical Journal* 2011, 343: d5094. doi: 5010.1136/bmj.d5094
16. Ramakrishnan U, Martorell R. The role of vitamin A in reducing child mortality and morbidity and improving growth. Salud Publica Mex. 1998 Mar-Apr;40(2):189-98.

17. Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS: Bellagio Child Survival Study Group. How many deaths can we prevent this year? *Lancet* 2003, 362:65–71.
18. World Health Organization: Global Strategy for Infant and Young Child Feeding. Geneva. 2003:URL: http://www.who.int/nutrition/publications/gs_infant_feeding_text_eng.pdf.
19. United Nations Children's Fund/World Health Organization: Baby friendly hospital initiative. Geneva, Switzerland: United Nations Children's Fund/World Health Organization. 2005.
20. Arifeen S, Black RE, Antelman G, Baqui A, Caulfield L, S. B: *Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums*. *Pediatr* 2001, 108(4):e67.
21. Betran AP, Onis M, Lauer JA, J. V: *Ecological study of effect of breast feeding on infant mortality in Latin America. . Br Med J* 2001, *323*:*1-5*.
22. Manda SOM: Birth intervals, breastfeeding and determinants of childhood mortality in Malawi. . *Social Science and Medicine* 1999, 48(3):301-312
23. Amare Deribew, Fasil Tessema, Belaineh Girma: Determinants of under-five mortality in Gilgel Gibe Field Research Center, Southwest Ethiopia. *EthiopJHealth Dev* 2007, 21(2):117-124.
24. Van den Broeck J, Eeckels R, Massa G: Maternal determinants of child survival in a rural African community. *International journal of epidemiology* 1996, 25(5):998-1004.
25. World Health Organization: Essential Newborn Care. Report of a Technical Working Group (Trieste, 25-29 April 1994), Division of Reproductive Health (Technical Support), WHO, Geneva, Switzerland, . 1996.
26. World Health Organization: Report of a WHO Technical Consultation on Birth Spacing. Geneva. 2006.
27. Nakamura H, Ikeda N, Stickley A, Mori R, Shibuya K: Achieving MDG 4 in sub-Saharan Africa: what has contributed to the accelerated child mortality decline in Ghana? *PloS one* 2008, 6(3).
28. Kayode GA, Adekanmbi VT, Uthman OA: Risk factors and a predictive model for under-five mortality in Nigeria: evidence from Nigeria demographic and health survey. *BMC Pregnancy and Childbirth* 2012, 12(10).
29. Ronsmans C: Birth spacing and child survival in rural Senegal. *International journal of epidemiology* 1996, 25(5):989-997.
30. Vos R, Ruth Lucia, Mauricio León, José Rosero, José Cuesta: Health. In: World Bank, and Inter-American Development Bank (2004) Ecuador: Creating Fiscal Space for Poverty Reduction. A Fiscal Management and Public Expenditure Review, Volume II, Report No. 28911-EC. Washington D.C. 2004.
31. Howlader AA, Kabir M, MMU B: Healthseeking Behavior of Mothers and Factors Affecting Infant and Child Mortality. *Demography in India* 2000, 28(2):225-238.
32. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions: At Wereda Level from 2014 – 2017. 2013, Addis Ababa, Ethiopia
33. Shifa GT, Ahmed AA, Yalew AW: Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia: A community based study. *BMC pediatrics* 2016, 16(1):30.
34. Kedir Teji, Yadeta Dassie, Nega Assefa, Tesfaye Gobena: Determinants of Infant Mortality in Kersa District, Eastern Ethiopia: A Case Control Study. Presented on World Federation of

Public Health, Addis Ababa Ethiopia, 2012.
URL:https://wfpha.confex.com/wfpha/2012/webprogram/Paper10261.html.
35. Mesganaw Fantahun, Yemane Berhane, Stig Wall, Peter Byass, Ulf Högberg. Women's involvement in household decision-making and strengthening social capital crucial factors for child survival in Ethiopia. Acta Paediatr. 2007 April 1; 96(4): 582–589.
36. Sileshi Garoma, Mesganaw Fantahun, Alemayehu Worku. Maternal Intimate Partner Violence Victimization and under-Five Children Mortality in Western Ethiopia: A Case-Control Study. JOURNAL OF TROPICAL PEDIATRICS, VOL. 58, NO. 6, 2012.
37. Girma B, Berhane Y: Children who were vaccinated, breast fed and from low parity mothers live longer: A community based case-control study in Jimma, Ethiopia. *BMC Public Health* 2011, 11(1).
38. Mosley WH, Chen LC: An analytical framework for the study of child survival in developing countries. 1984. *Bulletin of the World Health Organization* 2003, 81(2):140-145.
39. World health organizations. Technical Consultation on Postpartum and Postnatal Care: Department of making pregnancy safer; Switzerland; World Health Organization;. 2008. http://apps.who.int/iris/bitstream/10665/70432/1/WHO_MPS_10.03_eng.pdf. Accessed: September 04,2015
40. World Health Organization. WHO recommendations on Postnatal care of the mother and newborn. 2013. http://apps.who.int/iris/bitstream/10665/97603/1/9789241506649_eng.pdf?ua=1. Accessed: September 04,2015.
41. Singh K, Brodish P, Haney E: Postnatal care by provider type and neonatal death in sub-Saharan Africa: a multilevel analysis. *BMC Public Health* 2014, 14:941.
42. Debelew GT, Afework MF, Yalew AW. Determinants and Causes of Neonatal Mortality in Jimma Zone, Southwest Ethiopia: A Multilevel Analysis of Prospective Follow Up Study. PLoS ONE. 2014, 9(9): e107184. doi:10.1371/journal.pone.0107184.
43. Bahl R, Frost C, Kirkwood BR, Edmond K, Martines J, Bhandari N, Arthur P: Infant feeding patterns and risks of death and hospitalization in the first half of infancy: multicentre cohort study. *Bull World Health Organ* 2005, 83(6):418-426.
44. Jakobsen MS, Sodemann M, Biai S, Nielsen J, Aaby P: Promotion of exclusive breastfeeding is not likely to be cost effective in West Africa. A randomized intervention study from Guinea-Bissau. *Acta paediatrica (Oslo, Norway: 1992)* 2008, 97(1):68-75.
45. Van den Broeck J, Eeckels R, Massa G: Maternal determinants of child survival in a rural African community. *Int J Epidemiol* 1996, 25(5):998-1004.
46. World Health Organization: MATERNAL, NEWBORN, CHILD AND ADOLESCENT HEALTH: approved by the WHO GUIDELINES REVIEW COMMITTEE: Recommendations on newborn health. http://www.who.int/maternal_child_adolescent/documents/guidelines-recommendations-newborn-health.pdf. Accessed: September 03, 2015.
47. Eshetu Gurmu, Akim Mturi. Trends and Determinants of Infant and Child Mortality in Ethiopia: Could the MDG four be met? Southern African Journal of Demography. 2014. 15(1):49-80
48. Abir T, Agho KE, Page AN, Milton AH, Dibley MJ: Risk factors for under-5 mortality: evidence from Bangladesh Demographic and Health Survey, 2004-2011. *BMJ open* 2015, 5(8):e006722.

49. Kyei KA: Determinants of Childhood Mortality in South Africa: Using Categorical Data Modeling. *J Hum Ecol,* 2012, 37(1):47-56.
50. Kwakye K. O, Otupiri E., Dabo E. O., Browne E.N.L. Adjuik M. DETERMINANTS OF UNDER-FIVE MORTALITY IN BUILSA DISTRICT, UPPER EAST REGION, GHANA. Journal of Science and Technology, (2010), 30(1), 145-53.
51. Alam N, Van Ginneken JK, Bosch AM: Infant mortality among twins and triplets in rural Bangladesh in 1975-2002. *Tropical medicine & international health : TM & IH* 2007, 12(12):1506-1514.
52. Kembo J, Jeroen K. Van Ginneken: Determinants of infant and child mortality in Zimbabwe: Results of multivariate hazard analysis *Demographic Research* 2009, 21(13).
53. Uthman OA, Uthman MB, Yahaya I: A population-based study of effect of multiple birth on infant mortality in Nigeria. *BMC Pregnancy Childbirth* 2008, 8:41.

Table 1: Variables and their corresponding indicators used for sample size calculation

Determinant/exposure variables	**% of control exposed**	**%cases exposed**	**Confidence level**	**Power**	**No. cases**	**No. controls**	**Total**
Lack of antenatal care (ANC)	20.6	36.5	95%	80%	92	184	276
Home delivery	87.2	93.8	95%	80%	241	482	723
Lack of vaccination	27	66	95%	80%	18	36	54
Parity>=5	23.6	36.7	95%	80%	141	282	423
Birth interval<24m	13.3	28.8	95%	80%	78	155	233
No Exclusive breast feeding	14.1	28.1	95%	80%	96	192	288

Table 2: Association between personal illness controls related factors and childhood mortality, Gamo Gofa Zone, 2014

	Under-five*			Infants**		
Characteristics	AOR	[95% Conf. Interval]		AOR	[95% Conf. Interval]	
Had post-natal care for the index child						
Yes	Ref			Ref		
No	**2.27**	**1.25**	**4.11**	**2.35**	**1.02**	**5.45**
Number of ANC follow up for index pregnancy						
No ANC follow up	Ref			Ref		
Less than 4	0.88	0.51	1.54	0.58	0.27	1.24
Greater than or equal to 4	0.72	0.42	1.24	**0.45**	**0.23**	**0.90**
Place of delivery						
Home	Ref			Ref		
Hospital	1.42	0.31	6.44	1.76	0.27	11.53
Health center	0.96	0.20	4.64	0.95	0.13	7.00
Health post	1.72	0.72	4.15	2.24	0.66	7.56
Others	0.58	0.09	3.87	0.62	0.08	4.87
Attendant of delivery						
Skilled health professionals	Ref			Ref		
Health extension worker	0.64	0.14	2.88	0.37	0.05	2.74
TBA	0.36	0.07	1.90	0.47	0.05	4.05
Relative/Neighbor/Mother Herself	0.61	0.13	2.81	0.46	0.07	3.17
Immunization status of the child						
Fully immunized for age	Ref			Ref		
Partially immunized for age	**3.62**	**2.02**	**6.50**	**4.10**	**1.81**	**9.30**
Not immunized	**11.02**	**5.16**	**23.53**	**18.54**	**6.22**	**55.26**
Did the child have vit. A (for those >=6Month old)						
Yes	Ref			Ref		
No	**7.61**	**4.72**	**12.26**	**15.29**	**6.38**	**36.65**

*Besides variables in the table adjusted for sex of the child, mother's education, wealth index, husband occupation and marital status of the mother

** Besides variables in the table adjusted for sex of the child, mother's education, wealth index, husband occupation, marital status of the mother

Table 3: Association between Child feeding and newborn care practices and under-five mortality, Gamo Gofa Zone, 2014

	Under-five*			Infants**		
Characteristics	AOR	[95% Conf.Interval]		AOR	[95% Conf.Interval]	
Ever Breast fed						
Yes	RF					
No	**8.21**	**4.13**	**16.36**	**14.19**	**5.51**	**36.50**
First breast feeding started						
Within 1hr	Ref					
After 1hr	1.53	0.95	2.48	1.43	0.79	2.59
Breast feeding status within 6month of age						
Exclusive	Ref					
Predominantly	0.96	0.39	2.32	1.19	0.41	3.45
Partially	1.27	0.84	1.92	0.91	0.54	1.51
Bottle feeding						
Yes	Ref					
No	0.90	0.49	1.65	1.41	0.57	3.50
Timing of first bath						
Within 24 hour of birth	Ref					
After 24 hour of birth	**0.50**	**0.34**	**0.73**	**0.46**	**0.28**	**0.77**
Anything applied to umbilical wound						
Yes	Ref					
No	0.91	0.63	1.33	0.88	0.53	1.44

*Besides the variables in the model adjusted for significant distal factors (sex, mother's education, wealth index, husband occupation

** Besides the variables in the model adjusted for significant distal factors (sex, mother's education, wealth index, marital status of the mother

Table 4: Association between maternal and child factors with childhood mortality Gamo Gofa Zone, 2014

Characteristics	Under-five*			Infants**		
	AOR	[95% Conf. Interval]		AOR	[95% Conf. Interval]	
Age of mother at child birth	1.03	0.97	1.09	1.06	1.00	1.13
Number of pregnancies before index child	1.04	0.87	1.25	0.91	0.72	1.15
Birth order of index child						
first	Ref					
second	1.39	0.24	8.04	5.29	0.47	59.54
Third	2.02	0.35	11.53	3.73	0.40	34.88
fourth	1.39	0.25	7.66	4.35	0.47	40.03
Birth Interval						
<24months	Ref					
24-36months	**0.48**	**0.28**	**0.82**	**0.28**	**0.14**	**0.54**
>36months	**0.46**	**0.26**	**0.79**	**0.29**	**0.15**	**0.55**
first birth	1.01	0.16	6.45	0.64	0.07	5.66
History of child death before index child						
Yes	Ref					
No	**0.51**	**0.28**	**0.93**	**0.30**	**0.13**	**0.66**
Type of birth						
Single birth	Ref					
Multiple birth	**13.72**	**5.26**	**35.79**	**21.18**	**5.85**	**76.74**
History of child birth after index child						
No	Ref					
Yes	**5.06**	**2.80**	**9.16**			

*Besides variables in the table adjusted for sex of the child, mother's education, wealth index, husband occupation and marital status of the mother

** Besides variables in the table adjusted for sex of the child, mother's education, wealth index, marital status of the mother

Paper (Manuscript) IV- Relationship between under-five child death and maternal mental distress

The relationship between under-five child death and maternal mental distress in Gamo Gofa Zone, Southern Ethiopia: A community based comparative cross-sectional study

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Abstract

Background: Knowledge of the association between child death and maternal mental distress may help to highlight the indirect impact of reduction/prevention of under-five mortality on maternal mental wellbeing. This will have a positive impact on the development of the nation as depression is associated substantially with reduced quality of life and functional capacity for women. Although some studies conducted in the country assessed the magnitude of Common Mental Disorders (CMD) among postpartum mothers, studies which assessed the association between child death and maternal mental distress are lacking. Therefore, this study was conducted to assess the association between child death and maternal mental distress.

Methodology: A comparative cross-sectional study was conducted in 2014 on a total of 356 mothers who lost their children and 712 mothers with alive children. CMD symptoms were measured using the World Health Organization's (WHO's) self-reporting questionnaire (SRQ-20). A cut-off score of ≥ 6 was taken as an indicator of mental distress. To determine the relationship between child death and maternal mental distress, weighted conditional logistic regression was conducted with mental distress coded as a binary outcome.

Result: Mothers who lost children had significantly higher rate of mental distress (AOR of 1.84(1.11-3.04) compared to their counterparts. Similarly, mothers with child loss reported a significantly higher rate of suicidal ideation (23.3%) than mothers without child death (16.3%), with p-value of 0.003. The effect of child loss on maternal mental distress was greater during earlier periods (within 6 months of child death) and it decreased through time. However, it was shown to be persistently high at least during the first three years after child death, relative to mothers with alive child.

Conclusion: Significantly high proportions of women with child loss were experiencing mental distress than those without, including higher rate of suicidal ideation. Screening of maternal mental health problems by incorporating simple common mental distress assessing tools, like WHO's SRQ into the maternal and child health care programs of health facilities may have significant effect in reducing the impact of maternal mental health problems in the communities.

Key words: mental distress, common mental disorder, maternal mental distress, child loss, Gamo Gofa, Ethiopia

Background

In addition to economic losses mental disorders might bring, maternal mental disorder is associated with the wellbeing of children and the family. For example, studies have shown that early childhood failure to thrive (as measured by under nutrition and stunting), is significantly associated with depression in mothers [1, 2]. Maternal mental disorder was also shown to have negative effect on the subsequent pregnancy outcomes in the form of fatal congenital malformation, stillbirth and neonatal death [3]. Untreated maternal mental disorder has been shown to affect quality of child care [1] and child development [4, 5].

Depression in the mother may increase maternal mortality, through adversely affecting her physical health needs and through suicide. However, the earlier these conditions are recognized and addressed, the greater the chances of minimizing their impact [6].

Persons exposed to stressful life events are reported to experience mental disorders at a rate higher than those observed in the general population. For example, longitudinal studies of widowhood showed that bereaved ones may report psychological disturbance up to two years of the death of partner [7, 8].

The death of a child is undoubtedly, a highly traumatic life event for parents. Such traumatic pressure is more notable for mothers [9, 10]. This may be because it is the mother who carry the child in her womb and directly feel the pain of labor. The rate of hospitalization for psychiatric illnesses was reported to be high among mothers with child loss than those without in a study which analyzed data from national registers in Denmark [9]. This may indicate that mothers with child loss are prone to even severe mental disorders that need hospitalization. In a study conducted in Australia, the death of a very young child, as in the case of stillbirth and neonatal death, has also been shown to invoke severe emotional distress in parents [10].

Another study in Australia also demonstrated that, the death of a baby has an impact on women's mental health [11]. Mothers with child loss were found to be at increased risk for psychological distress at 2, 8, 15 and 30 months after their loss than mothers with live children [11]. A high rate of complicated grief among mothers who lost their children in health facilities was also reported by another study in United States of America [12] and complicated grief symptoms were shown

to persist in some participants up to 18 months after child death by a subsequent study [13]. The negative effects of death of a child are also shown to be longstanding in a study which analyzed data from Wisconsin Longitudinal Study [14].

It has been shown, however, that brief counseling after such loss can significantly reduce morbidity in parents after child death [15]. There is also strong evidence that, all stressful life events do not invariably cause psychological disturbance. The susceptibility to stressful life events varies from person to person because of genetic factors, coping style, type of personality and social support the person may have [16]. Even following highly traumatic events, such as the death of a spouse, only minorities of individuals appear to develop serious or ongoing psychological disorder [7, 17]. The effects are expected to be context dependent that the situation in developing countries needs to be investigated as almost all of the above studies are conducted in developed countries.

Showing the extent of the problem may help attract policy directions in order to intervene, as the recovery process with appropriate psychiatric intervention is expected to be accelerated and that helps to settle an uncomplicated grief reaction [18]. Social support was shown to have better psychological outcomes among bereaved parents too [19]. Some social support identified as reducing symptoms of mental illness after bereavement include: contact with other people, including friends, parents, spouses, surviving children, and other bereaved parents [20]. Besides, it may help to highlight the indirect impact of the reduction/prevention of child mortality on the maternal mental wellbeing which is shown to have a positive impact on the development of the nation as depression is associated substantially with reduced quality of life and functional capacity for the women [21]. Or it may highlight the synergistic benefit of health interventions targeting either of the problems. In Ethiopia, studies which assess the association between child death and maternal mental distress among bereaved mothers are lacking. Therefore, this study was conducted to examine the association between child death and maternal mental distress. We hypothesized that mothers with child loss would have a higher rate of mental distress than mothers with live children.

Methodology

Study area: This study was conducted in Gamo Gofa Zone, which is one of the 14 Zones in the Southern Nations Nationalities and People's Region (SNNPR). Gamo Gofa Zone has 15 Districts (Woredas) and two town administrations. Arba Minch Town, the Capital of Gamo Gofa Zone, is 502km south of Addis Ababa (the Capital of Ethiopia). There were three hospitals and 68 health centers providing health services for the population during the study period. Out of the 15 Districts and two town administrations of the Zone, Arba Minch Zuria District and Arba Minch Town were selected purposively. Arba Minch Zuria District was selected as Arba Minch DSS is based in the District and it includes kebeles (the smallest administrative units) from different climatic zones (high land, mid land and low land). Such wide agro-ecological nature of the study site may help to represent population of different agro ecological zones and enable us to generalize the findings to different population with similar background in developing countries in general and in the country in particular. As Arba Minch DSS is new site in the country, epidemiologic studies in general and mental health studies in particular are strictly limited. Arba Minch Town was included to represent the urban population of the zone. Further details of the study area were presented elsewhere [22].

Study Design and Period: A comparative cross-sectional study design was conducted in 2014.

Source and study population: The source population was all mothers with under-five children in the study area. The study population consisted of exposed mothers whose under five-children died in the period between

April 01, 2011 and September 30, 2014 and un-exposed mothers with alive children who were matched for date of birth of the index child (within one month) in the same kebele. The duration was selected with the assumption that it enables us to have adequate sample without compromising the information (minimum recall bias).

Inclusion and exclusion criteria: Only mothers who gave live-birth between January 01, 2008 and September 30, 2014 were included for the study (still births were excluded). Those mothers who could not be located/ communicated or died since then were excluded.

Sample size determination: The sample size was calculated using the statcalc program of

Epi info 7 statistical software package. The prevalence of mental distress among mothers without child death (considered as unexposed) was estimated to be 19.8%, which is obtained from a study conducted among postnatal mothers in the country [23]. Then, the sample size required for detecting an odds ratio of 1.71 with a two-sided alpha value of 5% and a power of 80% was determined with unexposed to exposed ratio of two. Accordingly, a minimum of 219 exposed and 438 unexposed (comparison group) were required. By applying a design effect of 1.5 and adding 10% to compensate for non-response, a total of 362 exposed and 724 unexposed were required.

Sampling technique: Arba Minch Zuria District and Arba Minch Town were selected purposively out of the 15 Districts and two town administrations of the Zone, respectively. Then, all the 11 kebeles of Arba Minch Town and the 9 kebeles of Arba Minch DSS were included (initially these kebeles were randomly selected out of 29 kebeles of the Arba Minch Zuria District) and additionally 11 non-DSS kebeles of Arba Minch District were selected randomly. Accordingly, 31 kebeles from the two Districts were included in this study (11 from Arba Minch Town and 20 from Arba Minch Zuria District). This part was further explained elsewhere [22].

A census of all kebeles of Arba Minch Town and 11 non-DSS kebeles of Arba Minch Zuria District was done in order to identify all children (and their respective mothers) who were born between September 01, 2008-September 30, 2014 and under five children who died between April 01, 2011 and September 30, 2014. Additionally, as the Arba Minch DSS has been tracking all births and deaths since its establishment in 2009, children born between August 01, 2009 and September 30, 2014 and under five children who died between April 01, 2011 and September 30, 2014 in Arba Minch DSS kebeles were tracked from the data base of the DSS.

Then, all mothers who lost under-five child between April 01, 2011 and September 30, 2014 were taken as exposed and two mothers with alive children who were matched for each exposed for date of birth of the index child (within one month) in the same kebele were taken as a comparison group. The two matched unexposed for a given exposed were selected randomly after identifying all possible unexposed for that specific exposed mother.

Data collection: Common mental disorder (CMD) symptoms were measured using the World

Health Organization's (WHO's) self-reporting questionnaire (SRQ-20) [24]. This 20-item questionnaire asks about depressive, anxiety and somatic symptoms which present in the past one month. The SRQ-20 initially consisted of 25 questions (20 related to neurotic symptoms, 4 concerning with psychotic symptoms and one asking about fits (convulsion)). Because of validation problems of SRQ-25, SRQ-20 was used in this study as it was validated in many countries including in Ethiopia. This instrument has been used in previous Ethiopian community-based studies [25-28], and was validated for use in perinatal women in Ethiopia [29]. A cut-off score of ≥ 6 was shown to have convergent validity [29]. The same cut-off point was used in this study and interview administered method using the Amharic Version of the questionnaire was employed. Besides, a quantitative questionnaire consisting of socioeconomic and demographic, health service utilization, reproductive characteristics of mothers was used.

Measurements

Dependent variable: Presence of mental distress or not (on SRQ20, yes to greater than or equal to 6 of the questions)

Independent variables: Primary: mortality status of the child. Secondary: socioeconomic &demographic, health service utilization, reproductive characteristics of the mothers

Operational definitions

Those women who answered 'yes' to six questions or more on the SRQ-20 were classified as having mental distress.

Wealth index: was computed using principal component analysis (PCA) of reported ownership of household assets such as radio, television, bicycle, livestock, etc and proxy indicator of living standard variables, like number of rooms the living house had, the roof of the house, whether the house is private or rental etc. The variables were adapted from Ethiopian Demographic and Health survey (EDHS) 2011 [30]. Then, the wealth status was categorized in to three groups and ranked from the poorest to the wealthiest.

Maternal power: was computed using PCA of 8 variables that were adapted from EDHS 2011 [30], which measure decision power of the mother in the household (decision on maternal and

husband income, on purchase and on visiting relatives or health facility (1 was assigned if the response favors maternal power (eg. if mother decides or jointly with her partner) other wise 0), perception on wife beating (0 if she justifies to at least for one in the list), if ever beaten by husband (0 if ever beaten), if husband assisted in house chore (0 if husband didn't assist)). Then, the maternal status was categorized in to three groups and ranked from poor, average to good.

Data processing, management and Quality Assurance: The questionnaires were pre-tested in kebeles which were not part of the study kebeles. Three days training was given to data collectors and supervisors on the questionnaires and the procedures. The data collection process was strictly followed up and problems encountered were discussed and immediate solutions were sought. Besides, double entry of 10% of the questionnaires was made to identify any discrepancy. All collected data were checked every day for their completeness, clarity and consistency by supervisors and the principal investigator. Then, data were cleaned and checked before data entry and analysis again. The data were edited, coded, entered into computer and cleaned using Epi Info Version 3.5.1.

Data analysis: Both descriptive and analytic analyses were performed. The data were analyzed using SPSS Version 16 and STATA version 11 statistical packages as appropriate. The prevalence of mental distress among mothers who lost child within a specified time duration (e.g. within the past 6 months before the survey) was determined and graphed. Open-epi version 2.3 was used to determine Extended Mantel-Haenszel chi square for linear trend, in order to assess the trend in the level of mental distress among mothers with child loss as time went on. To determine the association between child death and maternal mental distress, weighted conditional logistic regression was conducted with mental distress coded as a binary outcome (present or absent). The sampling weight was taken as the reciprocal of probabilities of selection. The probability of selection for urban was = 1/2*1*288/5745= 0.025 (as one out of 2 urban Districts and all the kebeles in selected District were included. Two hundred eighty eight out of 5745 children identified by the census were included). The corresponding sampling weight for urban was calculated to be 39.9. For that of rural =1/15*20/29*780/14416=0.0025(as one out of 15 rural Districts, twenty out of 29 kebeles of the District were included and 780 out of 14416 children identified were included in the study). The corresponding sampling weight for rural was calculated to be 402.

Model diagnostic was conducted using different STATA commands: For example, presence of specification error in the link term (logistic) or predictors was assessed with linktest command. Besides, the goodness of fit of the model was assessed by log likelihood chi-square test of the null hypothesis of no overall effect of predictors on the outcome and Akaike Information Criterion (AIC) to compare two models where one is nested on the other using estat ic command. Collin command was used to assess presence of multicollinearity among predictors. Tolerance value <=0.1 or variance inflation factor (VIF) of greater than or equal to 10 was taken as an indicator of presence of multicollinearity. All of the variables included in the model had VIF of less than five. Presence of interaction/effect modification was also assessed for suspected variables in the model.

Ethical considerations: Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Letters were written to all concerned bodies and permissions were secured at all levels. After explaining about the purpose of the study and confidentiality of the data, informed consent was obtained from each respondent. To assure confidentiality of the responses, anonymous interviews were conducted. Besides, the daily collected data were transferred to the Arba Minch University and locked in a secure cabinet.

Results

Socio-demographic characteristics of the respondents

Data from a total of 1068 mothers (356 exposed and 712 unexposed) were retrieved giving a response rate of 98.3%. The overall mean (SD) age of the mothers was 27.1(6.2) years. Majority of exposed (87.4%) and unexposed (89.9%) mothers were in the age group of 18-35 years. Majority of exposed (75.0%) and unexposed (74.3%) mothers were from Gamo Ethnic Group. Most of the exposed (67.4%) and unexposed (68.5%) mothers were protestant. More than half (56.2%) of exposed mothers lacked formal education, whereas, less than half (46.9%) of unexposed mothers had no formal education (table 1).

Majority of exposed (68.0%) and unexposed (70.6%) mothers were housewives. Majority of exposed (91.6%) and unexposed (94.1%) mothers were married at the time of the survey. Fifty nine (18.1%) of exposed mothers' husband were daily laborers whereas, only 7.9% of unexposed mothers' husband were daily laborers. Two hundred eight (63.8%) of exposed and 68.9% of unexposed mothers' husbands had at least primary level education. With regard to wealth index, 42.1% of exposed and 39% of unexposed mothers were from poor households. One hundred twenty four (34.8%) of exposed and 29.6% unexposed mothers had poor decision making status in the household (table 1).

Mental distress among the study participants

The internal reliability of the SRQ-20 was excellent with Cronbach's alpha of 0.902. As depicted in table 2, the most commonly reported symptoms include: "headache" (52.8%), "easily tire" (43.2%), "feel tired all the time" (40.2%) and "feel nervous, tense or worried" (38.2%). Overall 18.6% of the mothers reported that they had suicidal ideation within the last 30 days before the survey. Significantly, higher rate of suicidal ideation was reported by exposed mothers (23.3%) than unexposed ones (16.3%), p-value of 0.003.

The overall mean (SD) score value was 5.7 ± 5.1 ranging between 0 and 20. The

mean (SD) scores for exposed mothers was significantly higher than that of unexposed mothers (6.4 ± 5.3 vs ±5.1). Based on a cutoff point of six or above yeses to the SRQ questions, overall, 41.8% (95% confidence interval (CI) of 0.39%-0.45%) of the participants were positive for mental distress. The proportion of exposed mothers who were positive for mental distress was 48% (95% CI of 42.9%-53.2%), whereas only 38.6% (95% CI of 35.1%-42.3%) of unexposed mothers were positive (Table 2).

As shown on figure1, the magnitude of maternal mental distress among mothers with child death was shown to be decreasing as time went on. The magnitude of mental distress was 55.7% among mothers who experienced child loss in the past six months. It decreased to 43% among mothers who experienced child loss more than three years before the survey, but it was persistently high among mothers with child loss than mothers without child loss at least for three to four years after child death (X^2=10.65, P= 0.001) (Figure 1). Maternal mental distress was also shown to be high if the child died at his/her older age (Figure 2).

Association between child death and maternal mental distress

In the bivariate analysis, history of child loss was significantly associated with mental distress. The odds of mental distress was 1.6 times higher among mothers who lost their children than those who didn't (COR=1.61(1.15-2.25)). After adjusting for potential confounding factors, the odds of mental distress among mothers with child death was about 1.8 times higher than among those mothers without child death (AOR of 1.84(1.11-3.04) (table 3).

Other variables which were significantly associated with overall maternal mental distress include: wealth index of the household, whether the mother reported to have other medical illnesses or not, whether the family sought medical care from modern health system or not, whether the mother had antenatal care (ANC) follow up during the pregnancy of the index child or not and whether the mother had history of adverse pregnancy outcome (abortion or still birth) or child loss other than the death of the index child (table 3).

Overall, mothers from household of average (AOR of 0.41(0.21-0.79)) and rich (AOR of

0.31(0.14-0.67)) wealth index had less odds of mental distress than those from poor categories. The odds of mental distress among mothers who didn't report to have other medical problems (including heart problems, hypertension, diabetes mellitus etc) was 64% (AOR of 0.36(0.18- 0.73)) less than among those who reported to have any other medical problems. Similarly, odds of mental distress among mothers who reported seeking medical care from modern health facilities (other than home or traditional healer) was 57% (AOR of 0.43(0.20-0.94)) less than among those mothers who reported to seek from traditional means. Compared to those mothers who reported to have ANC follow up during pregnancy of the index child, the odds of mental distress was about 2.6 times (AOR of 2.55(1.25-5.18)) higher among who didn't have ANC follow up (table 3).

Discussion

Although studies conducted in the country assessed the magnitude of mental distress among postpartum mothers [23] and the effect of maternal mental distress on child wellbeing [31, 32], none of them tried to assess the association between child death and maternal mental distress. This study bridged this gab by assessing the association between child loss and maternal mental distress.

This study demonstrated that, child loss is significantly associated with maternal mental distress. Mothers who lost their child had significantly high rate of mental distress than their counterparts. Similarly, mothers with child loss reported a significantly high rate of suicidal ideation than mothers without child death. This finding is consistent with other previous studies [10, 11]. Similarly, high rate of hospitalization for psychiatric illnesses among mothers with child loss than those without was reported by another study [9]. This may be an indication that, mothers with child loss are prone to even severe mental illnesses which may require hospitalization that warrant mental health intervention for mothers with child loss by integrating mental health services to other maternal health services.

The effect of child loss on maternal mental distress was greater during earlier periods (within 6 months of child death) and it decreased through time. However, it was shown to be persistently high at least during the first three years after child death than among mothers without child loss. Similar finding was observed by other studies [11, 13] that, mental distress among mothers with child loss persists for a longer duration. It was reported to persist up to 30 months after child death [11]. Risk of hospitalization for any psychiatric disorder was also reported to remain significantly high among mothers who lost their children even after five years of child death [9].

This persistent maternal mental distress after child loss may have impact on the subsequent children, which may lead to a vicious cycle of the problem. Previous studies revealed a significant association between history of death of older sibling of the child with the death of the index child [33-35]. It was also shown that child wellbeing was significantly associated with maternal mental distress [1, 2, 31]. All these dictate the importance of mental health interventions targeting mothers with child loss, not only for the mother, but also for her children.

Congruent to this suggestion, cognizant of high rate of mental health problems during pregnancy and postnatal period and only small proportion of women require specialist support and psychotropic medicines, WHO recommends, training of health care providers at primary level in order to identify symptoms and signs suggestive of mental health problems and provide counselling to women about stress as well as provide other interventions [6].

This study also assessed other associated factors of mental distress among overall mothers. Overall, mothers from households of average and rich wealth index had less odds of mental distress than those from poor categories. Similar findings were reported by other studies [36, 37], indicating that poor women were more likely to have postpartum depression than rich ones. This may be as a result of stress, worries and insecurities in feeding and sheltering the families in general and children in particular or due to the situation they are living in, as they are more likely to live in crowded or stressful conditions and to have less occupational opportunities.

Mothers who reported to have other medical problems had a high rate of mental distress than those without. Similar finding was reported by another study of postnatal mothers [36], that presence of other medical illness was significantly associated with mental distress. Similar finding was observed by study of the general population [38]. Bidirectional link between mood disorders and medical illnesses was also underscored by a scientific review of literatures [39]. It was also reported that mood disorders affect the course of medical illnesses [39]. All these may signify the importance of integrating mental health interventions (including screening, counseling and referral of those in need) with management of other medical problems.

Mothers who had ANC follow up during the pregnancy of the index child had less odds of mental distress than those who didn't. This may be because of the benefit of the general counseling provided by health workers on general health of the mother and her child. This may be an indication for the benefit that might be extracted by such mothers if mental health related counseling is integrated with maternal health services, including during ANC follow up. Such counselling may help mothers to cope with stressful events they may face.

Because of the observational nature of the study design, some systematic errors, such as recall and social desirability biases could not be completely avoided. For example, the response of the respondents about household assets, mothers' decision power in the household could be

prone to recall and social desirability biases. Again, because of cross-sectional nature of the design, temporal relationship between child death and maternal mental distress couldn't be established in this study.

Conclusions

In conclusion, significantly high proportions of women with child loss were experiencing mental distress than those without child loss. Significantly, high rate of suicidal ideations were also reported by these group of women. Even though the effect was shown to decrease through time, it persisted significantly high for relatively longer duration (at least three years after child death) than among those without child death. These warrant urgent requirement of actions at least for these groups of mothers.

Those mothers who lacked ANC follow up during pregnancy of the index child were shown to have high rate of mental distress than those who had. Screening of maternal mental health problems by incorporating simple common mental distress assessing tools such as SRQ-20 into the maternal and child health care programs of health facilities (for screening, counseling and referral of those in need) may have significant impact in reducing the impact of maternal mental health problems in communities.

As significantly high rate of mental distress was observed among mothers from poor households, investing on household income generation activities may be taken as one of the measures of tackling maternal mental health problems in the communities. Similarly, as mothers with other medical illnesses were more likely to have high rate of mental distress, creating awareness of health service providers about this link may help to reduce maternal mental health problems by letting them screen these group of mothers for possible mental disorders for appropriate action.

The feasibility and effectiveness of provision of simple psychosocial interventions, such as screening for maternal mental distress using simple screening tools, basic counseling and emotional support by front line health workers such as health extension workers need to be explored in Ethiopia. Further study with stronger design will be helpful to establish cause-effect relationship between child death and maternal mental distress in Ethiopian context. Finally, as the study areas of this study were similar with not only to most of the rural communities in Ethiopia but also to many other communities in developing countries in terms of demographics, health services and economic structure. This may allow the findings of this study to be generalized to communities with similar backgrounds in developing countries in general and in Ethiopia in particular.

Declarations

List of abbreviations

ANC: Antenatal care

AOR: Adjusted Odds Ratio

CI: Confidence interval

CMD: Common Mental Disorders

COR: Crude odds ratio

DSS: Demographic surveillance System

EDHS: Ethiopian Demographic and Health survey

PCA: principal component analysis

SD: Standard deviation

SRQ: self-reporting questionnaire

VIF: variance inflation factor

WHO: World health organization

Ethics approval and consent to participate: Ethical clearance and approval was obtained from the Institutional Review Board of the College of Health Sciences at Addis Ababa University. Letters were written to all concerned bodies and permissions were secured at all levels. After explaining about the purpose of the study and confidentiality of the data, informed consent was obtained from each respondent. To assure the confidentiality of the responses, anonymous interviews were conducted.

Consent to Publish: Not applicable

Availability of Data and Materials***:*** The data supporting this publication are summarized with tables and figure in the manuscript. However, if the raw data is required, it can be accessed from the authors whenever required using appropriate procedure and format.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: Conceived and designed the study: GTS AAA AWY. Conducted the study: GTS AAA AWY. Analyzed the data: GTS AAA AWY. Wrote the paper: GTS AAA AWY. Read the final manuscript and approved for submission: GTS AAA AWY.

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References

1. Patel V, Rahman A, Jacob KS, Hughes M. Effect of maternal mental health on infant growth in low income countries: New evidence from South Asia. BMJ. 2004;328:820–823.
2. Rahman A, Lovel H, Bunn J, Iqbal Z, Harrington R. Mothers mental health & infant growth: a case-control study from Rawalpindi, Pakistan. Child Care Health Dev. 2003, 30: 21–27.
3. King-Hele S, Webb RT, Mortensen PB, Appleby L, Pickles A, KM. A: Risk of stillbirth and neonatal death linked with maternal mental illness: a national cohort study. Arch Dis Child Fetal Neonatal Ed 2009, 94(2):105-110.
4. Walker SP, Wachs TD, Gardner JM, Lozoff B, Wasserman GA, et al. Child development: risk factors for adverse outcomes in developing countries. Lancet. 2007, 13(369): 145–157.
5. Cooper PJ, Murray L, Wilson A, Romaniuk H. Controlled trial of the short- and long-term effect of psychological treatment of post-partum depression. Brit J Psychiat. 2003, 182: 412–419.
6. World Health organization, Department of Mental Health and Substance Abuse. Improving Maternal Mental Health. Geneva. 2008. URL: http://www.who.int/mental_health/prevention/suicide/Perinatal_depression_mmh_final.pdf. Accessed on July 20, 2015.
7. Zisook S, Shuchter SR, Sledge PA, Paulus MP, Judd LL. The spectrum of depressive phenomena after spousal bereavement. J. Clin. Psyehiat. 1994, 55(Suppl.), 29-36.
8. Stroebe W, Stroebe MS, Domittner G. Individual and situational differences in recovery from bereavement: a risk group identified. J. Soc. Iss. 1988, 44(3), 143-158
9. Li J, Laursen TM, Precht DH, Olsen J, Mortensen PB. Hospitalization for Mental Illness among Parents after the Death of a Child. N Engl J Med 2005;352:1190-6. URL: http://www.nejm.org/doi/pdf/10.1056/NEJMoa033160. Accessed on July 15, 2015.
10. Vance JC, Foster WJ, Najman JM, Embelton G, Thearle MJ, Hodgen FM. Early parental responses to sudden infant death, stillbirth or neonatal death. Med. J. Aust. 1991, 155, 292-7.
11. Boyle FM, Vance JC, Najman JM, Thearle MJ. The mental health impact of stillbirth, neonatal death or Sudden infant death syndrome(SIDS): prevalence and patterns of distress among mothers. Soc. Sci. Med. 1996; 43(8), 1273-1282.
12. Meert KL, Donaldson AE, Newth CJ, Harrison R, Berger J, Zimmerman J, Anand KJ, Carcillo J, Dean JM, Willson DF et al: Complicated grief and associated risk factors among parents following a child's death in the pediatric intensive care unit. Archives of pediatrics & adolescent medicine 2010, 164(11):1045-1051.
13. Meert KL, Shear K, Newth CJ, Harrison R, Berger J, Zimmerman J, Anand KJ, Carcillo J, Donaldson AE, Dean JM et al: Follow-up study of complicated grief among parents eighteen months after a child's death in the pediatric intensive care unit. Journal of palliative medicine 2011, 14(2):207-214.

14. Rogers CH: The Effect of the Death of a Child on Midlife Mental and Physical Health: An Exploration of Risk and Resilience Factors". Psychology Dissertations. Paper 8. Georgia State University. URL: http://scholarworks.gsu.edu/cgi/viewcontent.cgi?article=1007&context=psych_diss. accessed August 10, 2015. 2005.
15. Forrest GC, Standish E, Baum JD. Support after perinatal death: a study of support and counselling after perinatal bereavement. BMJ 1982; 285: 1475-79.
16. Salleh MR: Life event, stress and illness. The Malaysian journal of medical sciences: MJMS 2008, 15(4):9-18.
17. Vachon, M. L. S., Rogers, J., Lyall, W. A. L., Lancee, W. J., Sheldon, A. R., & Freeman, S. J. J. Predictors and correlates of adaptation to conjugal bereavement. American Journal of Psychiatry, 1982, 139(8), 998-1002.
18. Lindemann E. Symptomatology and management of acute grief'. American Journal of Psychiatry, 1944, 101(2), 141-148.
19. World Health Organisation-Regional Office for Europe. Impact of economic crises on mental health. Copenhagen, Denmark. 2007. URL: http://www.euro.who.int/ data/assets/pdf_file/0008/134999/e94837.pdf. Accessed on May 25, 2015.
20. Wheeler I. Parental bereavement: The crisis of meaning. Death Studies. 2001, 25, 51- 61.
21. UNFPA/WHO. Maternal mental health and child health and development in resource-constrained settings: Report of a UNFPA/WHO international expert meeting: the interface between reproductive health and mental health, Hanoi, June 21-23, 2007. URL: http://www.who.int/reproductivehealth/publications/general/rhr_09_24/en/. Accessed on July 12, 2015.
22. Shifa GT, Ahmed AA, Yalew AW: Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia: A community based study. BMC pediatrics 2016, 16(1):30.
23. Baumgartner JN, Parcesepe A , Mekuria YG, Abitew DB, Gebeyehu W, Okello F, Shattuck D: Maternal mental health in Amhara region, Ethiopia: a cross-sectional survey. Global health, science and practice 2014, 2(4):482-486.
24. Beusenberg M, Orley J. World Health Organisation; A user's guide to the Self-Reporting Questionnaire (SRQ). 1994, Geneva. URL: http://apps.who.int/iris/bitstream/10665/61113/1/WHO_MNH_PSF_94.8.pdf. Accessed on January 10, 2014.
25. Alem A, Kebede D, Woldesemiat G, Jacobsson L, Kullgren G. The prevalence and socio-demographic correlates of mental distress in Butajira, Ethiopia. Acta Psychiatrica Scandinavica. Supplementum. 1999;397:48–55.
26. Senturk V, Hanlon C, Medhin G, Dewey M, Araya M, Alem A, Prince M, Stewart R: Impact of perinatal somatic and common mental disorder symptoms on functioning in Ethiopian women: The P-MaMiE population-based cohort study. Journal of affective disorders 2012, 136 (3):340-349.

27. Damena T, Mossie A, Tesfaye M: Khat Chewing and Mental Distress: A Community Based Study, in Jimma City, Southwestern Ethiopia. Ethiop J Health Sci 2011, 21(1):37-45.
28. Gelaye B, Lemma S, Deyassa N, Bahretibeb Y, Tesfaye M, Berhane Y, Williams MA: Prevalence and Correlates of Mental Distress Among Working Adults in Ethiopia. Clin Pract Epidemiol Ment Health 2012, 8:126-133.
29. Hanlon C, Medhin G, Alem A, Araya M, Abdulahi A, Hughes M, Tesfaye M, Wondimagegn D, Patel V, Prince M. Detecting perinatal common mental disorders in Ethiopia: validation of the self-reporting questionnaire and Edinburgh Postnatal Depression Scale. Journal of Affective Disorders. 2008;108:251–262.
30. Ethiopia Demographic and Health Survey: Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistics Agency and ORC Macro 2011. 2011.
31. Ross J, Hanlon C, Medhin G, Alem A, Tesfaye F, Worku B, Dewey M, Patel V, Prince M: Perinatal mental distress and infant morbidity in Ethiopia: a cohort study. Arch Dis Child Fetal Neonatal Ed 2011, 96:59–64.
32. Medhin G, Hanlon C, Dewey M, Alem A, Tesfaye F, Lakew Z, Worku B, Aray M, Abdulahi A, Tomlinson M et al: The effect of maternal common mental disorders on infant undernutrition in Butajira, Ethiopia: the P-MaMiE study. BMC psychiatry 2010, 10:32.
33. Kwakye KO, Otupiri E, Dabo EO, Browne ENL, Adjuik M. DETERMINANTS OF UNDER-FIVE MORTALITY IN BUILSA DISTRICT, UPPER EAST REGION, GHANA. Journal of Science and Technology, 2010, 30(1), 145-53.
34. Abir T, Agho KE, Page AN, Milton AH, Dibley MJ: Risk factors for under-5 mortality: evidence from Bangladesh Demographic and Health Survey, 2004-2011. BMJ open 2015, 5(8):e006722.
35. Kyei KA: Determinants of Childhood Mortality in South Africa: Using Categorical Data Modeling. J Hum Ecol, 2012, 37(1):47-56.
36. Pollock JI, Manaseki-Holland S, Patel V: Depression in Mongolian women over the first 2 months after childbirth: prevalence and risk factors. Journal of affective disorders 2009, 116(1-2):126-133.
37. Chandran M, Tharyan P, Muliyil J, Abraham S: Post-partum depression in a cohort of women from a rural area of Tamil Nadu, India. Incidence and risk factors. The British journal of psychiatry: the journal of mental science 2002, 181:499-504.
38. Patel V, Kirkwood BR, Pednekar S, Weiss H, Mabey D: Risk factors for common mental disorders in women. Population-based longitudinal study. The British journal of psychiatry: the journal of mental science 2006, 189:547-555.
39. Evans DL, Charney DS, Lewis L, Golden RN, Gorman JM, Krishnan KR, Nemeroff CB, Bremner JD, Carney RM, Coyne JC et al: Mood disorders in the medically ill: scientific review and recommendations. Biological psychiatry 2005, 58(3):175-189.

Table 1: Socio-demographic characteristics of the participants, Gamo Gofa Zone, 2014

Characteristics	Categories	Exposed	Unexposed	Total
		N (%)	N (%)	N (%)
Age category of the mother	<18yr	7(2.0)	11(1.5)	18(1.7)
	18-35yr	311(87.4)	640(89.9)	951(89.0)
	>35	38(10.7)	61(8.6)	99(9.3)
Ethnicity	Gamo	267(75.0)	529(74.3)	796(74.5)
	Gofa	7(2.0)	19(2.7)	26(2.4)
	Wolayta	25(7.0)	47(6.6)	72(6.7)
	Zeyse	37(10.4)	78(11.0)	115(10.8)
	Amhara	5(1.4)	19(2.7)	24(2.2)
	others	15(4.2)	20(2.8)	35(3.3)
Religion	Protestant	240(67.4)	488(68.5)	728(68.2)
	Orthodox	101(28.4)	196(27.5)	297(27.8)
	Others	15(4.3)	28(3.9)	43(4.1)
Educational level	No formal education	200(56.2)	334(46.9)	534(50.0)
	Grade1-6	100(28.1)	174(24.4)	274(25.7)
	Grade7-8	22(6.2)	71(10.0)	93(8.7)
	Grade9-12	18(5.1)	85(11.9)	103(9.6)
	Above grade12	16(4.5)	48(6.7)	64(6.0)
Occupation	Farmer	18(5.1)	35(4.9)	53(5.0)
	House wife	242(68.0)	503(70.6)	745(69.8)
	Gov't employee	19(5.3)	48(6.7)	67(6.3)
	Merchant	41(11.5)	81(11.4)	122(11.4)
	Daily laborer	21(5.9)	11(1.5)	32(3.0)
	Housemaid	3(0.8)	4(0.6)	7(0.7)
	Student	9(2.5)	22(3.1)	31(2.9)
	Other	3(0.8)	8(1.1)	11(1.0)
Marital status	Married	326(91.6)	670(94.1)	996(93.3)
	Single	7(2.0)	20(2.8)	27(2.5)
	Divorced	6(1.7)	5(0.7)	11(1.0)
	Widowed	9(2.5)	4(0.6)	13(1.2)
	Separated	8(2.2)	13(1.8)	21(2.0)
Husband occupation	Farmer	177(54.3)	401(59.9)	578(58.0)
	Gov't employee	32(9.8)	91(13.6)	123(12.3)
	Merchant	25(7.7)	64(9.6)	89(8.9)
	Student	5(1.5)	10(1.5)	15(1.5)
	Daily laborer	59(18.1)	53(7.9)	112(11.2)
	Other	28(8.6)	51(7.6)	79(7.9)
Husband education	No formal education	118(36.2)	208(31.1)	326(32.7)
	Grade 1-6	108(33.1)	187(27.9)	295(29.6)
	Grade 7-8	34(10.4)	78(11.6)	112(11.2)
	Grade 9-12	34(10.4)	113(16.9)	147(14.8)
	>Grade 12	32(9.8)	84(12.5)	116(11.6)
Wealth index	Poor	150(42.1)	278(39.0)	428(40.1)
	Average	90(25.3)	127(17.8)	217(20.3)
	Rich	116(32.6)	307(43.1)	423(39.6)
Maternal Power	Poor	124(34.8)	211(29.6)	335(31.4)
	Average	125(35.1)	260(36.5)	385(36.0)
	Good	107(30.1)	241(33.8)	348(32.6)

Table 2: Proportion of exposed and unexposed mothers who said yes to SRQ 20 questions, Gamo Gofa Zone, 2014

S. No.	SRQ 20-Questions	Exposed (who said yes)	Unexposed (who said yes)	Total (who said yes)
		Freq. (%)	Freq. (%)	Freq. (%)
1.	Often had headache	201(56.5)	363(51.0)	564(52.8)
2.	Had poor appetite	132(37.1)	273(38.3)	405(37.9)
3.	Problem with sleep	90(25.3)	164(23.0)	254(23.8)
4.	Easily frightened	86(24.2)	161(22.6)	247(23.1)
5.	Hands shake	39(11.0)	66(9.3)	105(9.8)
6.	Feel nervous, tense or worried	159(44.7)	249(35.0)	408(38.2)
7.	Poor digestion	92(25.8)	153(21.5)	245(22.9)
8.	Trouble thinking clearly	108(30.3)	185(26.0)	293(27.4)
9.	Feel unhappy?	121(34.0)	189(26.5)	310(29.0)
10.	Cry more than usual	81(22.8)	114(16.0)	195(18.3)
11.	Difficulty to enjoy daily activities	106(29.8)	165(23.2)	271(25.4)
12.	Difficulty to make decisions	92(25.8)	147(20.6)	239(22.4)
13.	Daily work suffering	106(29.8)	174(24.4)	280(26.2)
14.	Unable to play a useful part in life	114(32.0)	188(26.4)	302(28.3)
15.	Lost interest in things	115(32.3)	175(24.6)	290(27.2)
16.	Feeling of worthlessness	111(31.2)	155(21.8)	266(24.9)
17.	Thought of ending life	83(23.3)	116(16.3)	199(18.6)
18.	Feel tired all the time	162(45.5)	267(37.5)	429(40.2)
19.	Uncomfortable feelings in stomach	116(32.6)	212(29.8)	328(30.7)
20.	Easily tired	164(46.1)	297(41.7)	461(43.2)
Positives for mental distress (95% CI)		48.0(42.9-53.2)	38.6 (35.1-42.3)	41.8 (0.39-0.45)

Table 3: Independent association of maternal mental distress with child loss and other factors, Gamo Gofa, 2014

Characteristics	Categories	COR	95% CI		AOR*	95% CI	
Exposure status	Un-exposed	**Ref**			Ref		
	Exposed	**1.61**	**1.15**	**2.25**	**1.84**	**1.11**	**3.04**
Age of mother at birth		1.02	0.99	1.06	1.02	0.96	1.08
Ethnicity	Gamo	Ref			Ref		
	Zeyse	0.50	0.10	2.46	0.34	0.03	3.71
	Wolayta	2.22	0.72	6.88	3.28	0.92	11.70
	Others	0.98	0.31	3.95	0.88	0.27	2.87
Maternal education	No formal education	Ref			Ref		
	Grade1-6	1.16	0.67	1.99	**2.00**	**1.01**	**3.97**
	Grade7-8	0.94	0.43	2.06	2.17	0.88	5.36
	Above Grade9	0.70	0.32	1.53	1.86	0.66	5.30
Marital status	Married	Ref			Ref		
	Single	0.85	0.26	2.79	0.50	0.09	2.61
	Other	1.15	0.47	2.81	1.17	0.36	3.82
Mother Occupation	House wife	Ref			Ref		
	Farmer	0.49	0.21	1.15	0.68	0.26	1.73
	Gov't employee	0.37	0.04	3.14	0.56	0.08	3.73
	Merchant	0.97	0.48	1.94	1.00	0.43	2.33
	Others	1.82	0.70	4.70	1.41	0.51	3.89
Wealth index	Poor	Ref			Ref		
	Average	**0.47**	**0.26**	**0.84**	**0.41**	**0.21**	**0.79**
	Rich	**0.39**	**0.20**	**0.77**	**0.31**	**0.14**	**0.67**
Maternal Power	Poor	Ref			Ref		
	Average	0.76	0.46	1.26	0.62	0.32	1.19
	Good	1.19	0.71	2.01	1.45	0.76	2.79
Ever beaten by her husband	Yes	Ref			Ref		
	No	0.98	0.53	1.82	1.08	0.49	2.40
Mother has any medical illness	Yes	Ref			Ref		
	No	**0.42**	**0.23**	**0.76**	**0.36**	**0.18**	**0.73**
Place of seeking health care	Traditional	Ref			Ref		
	Modern health service	**0.43**	**0.22**	**0.85**	**0.43**	**0.20**	**0.94**
Pregnant during survey	Yes	Ref			Ref		
	No	0.75	0.38	1.47	0.65	0.32	1.34
	Unsure	0.80	0.18	3.60	0.41	0.10	1.63
How many child has		1.02	0.93	1.12	1.09	0.93	1.28
Place of delivery	Home	Ref			Ref		
	Health post	0.98	0.36	2.63	0.52	0.17	1.61
	Higher health facility	0.87	0.47	1.60	0.58	0.25	1.37
Had Post natal care during pregnancy of index child	Yes	Ref			Ref		
	No	1.00	0.58	1.73	0.54	0.25	1.18
Had ANC follow up during pregnancy of index child	Yes	Ref			Ref		
	No	**1.81**	**1.01**	**3.24**	**2.55**	**1.25**	**5.18**
Ever had child loss (including abortion & stillbirth) other than index child	Yes	Ref			Ref		
	No	**0.54**	**0.34**	**0.87**	0.60	0.33	1.08
Had live birth after index child	Yes	Ref			Ref		
	No	0.87	0.57	1.33	1.03	0.61	1.76

*Adjusted for all variables in the table

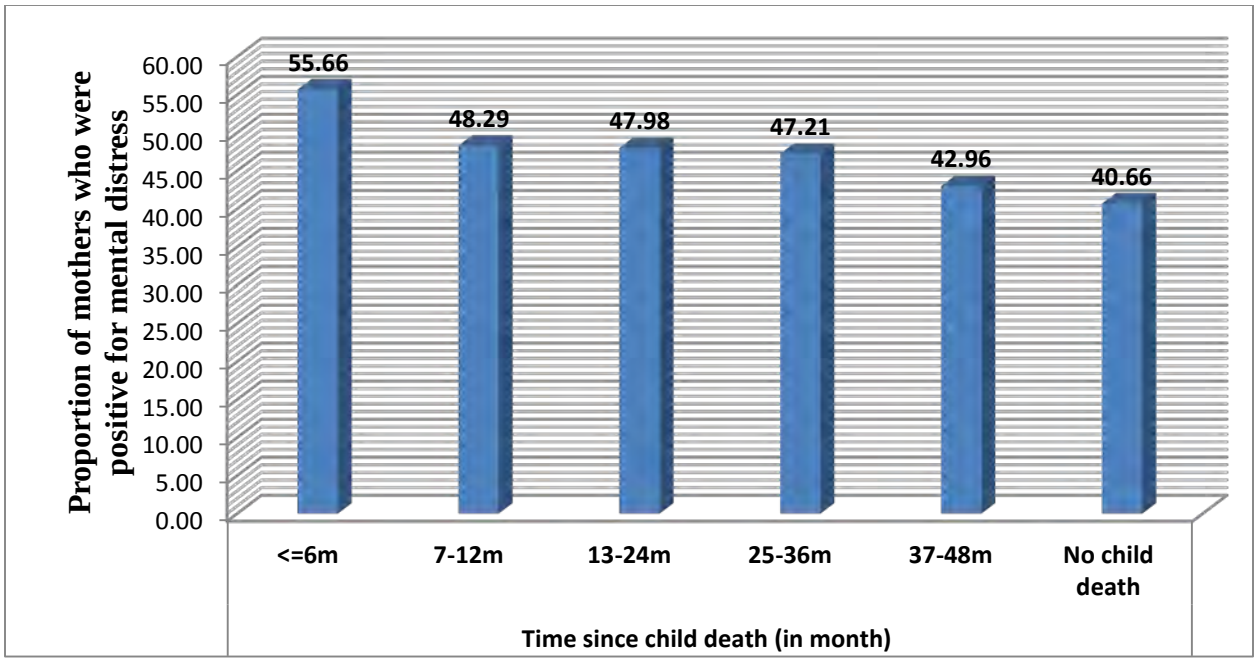

Figure 1: Proportion of mothers who had mental distress, by time since child death, Gamo Gofa Zone, Ethiopia, 2014

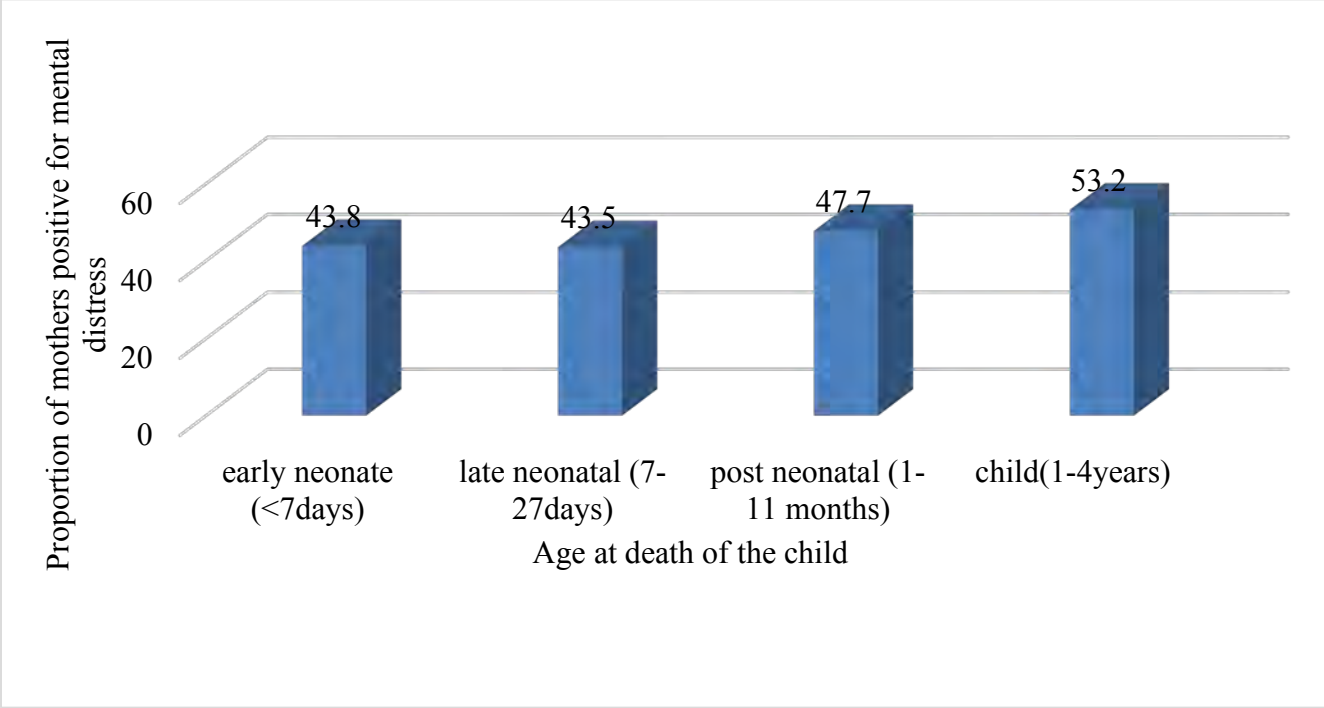

Figure 2: Proportion of mothers who had mental distress, by age of the child at death, Gamo Gofa Zone, Ethiopia, 2014

13.Declaration

LETTER FOR DECLARATION (Dissertation work)

I, the under signed, declared that this is my original work, has never been presented in this or any other University, and that all the resources and materials used for the dissertation, have been fully acknowledged.

Name: _____

Signature: _____

Date: _____

Place: _____

Date of submission: _____

This dissertation has been submitted for examination with my approval as University Supervisor.

Name: _____

Signature: _____

Date: _____