**Pre-analysis plan**

**Quality of antenatal care and newborn health: findings from a cohort study in Ethiopia, Kenya, and South Africa**

**Background**

Previous studies and systematic reviews have assessed associations between antenatal care (ANC) and neonatal mortality. [1-3] Most studies examined the effect of at least one ANC visit or the number of ANC visits on newborn outcomes. A systematic review and meta-analysis investigating the effect of ANC on neonatal mortality found that at least one ANC visit with a skilled provider during pregnancy could reduce the risk of neonatal mortality by 39% in sub-Saharan African countries where the studies took place. [1] These analyses may have been limited. A Cochrane review analyzed the effects of specific antenatal care interventions (such as nutrition interventions, malaria prevention, and midwives-led models of care) on fetal loss. [4] Most evidence has been based on retrospective cross-sectional surveys. The evidence on associations between the quality of ANC and perinatal survival and newborn health remains limited.

**Data source**

This paper will use data from the eCohort study a longitudinal prospective survey on health system quality for maternal and newborn health. Pregnant women were enrolled during their first ANC visit and followed through pregnancy and delivery. The study took place in two sites in each country: one predominantly urban and one rural. Women were recruited in public and private health facilities in Ethiopia and Kenya and in public primary care facilities only in South Africa.

**Objectives**

The present paper will assess associations between the quality of the first ANC visit and late pregnancy losses, low birth weight and perinatal mortality.

**Key variables**

**Confounders**

First, we will describe the characteristics of women who were followed until delivery in each country (**table 1**). We will report their sociodemographic status, baseline health conditions, including having any chronic illnesses or obstetric risk factors. These will include educational status, marital status, health literacy, wealth tertile (based on asset variables measured at baseline). Health status will include self-reported health, experience of danger signs at baseline, presence of any pregnancy risk factors and known multiple pregnancy at baseline. Models will also be adjusted for gestational age in trimester at the first ANC visit. Pregnancy risk factors will include any self-reported chronic illness, anemia (<11g/dL, undernutrition (MUAC <23cm or BMI<18.5), obesity BMI>=30, age under 19 or over 35, or history of prior obstetric complications). Women will be classified as having no risk factor, at least one, at least two or three or more risk factors.

We will then present the birth outcomes, including late miscarriages, stillbirths, live births, early neonatal death, late neonatal death and birth weight (**table 2**).

***Primary outcomes***

The primary analysis will assess associations between the quality of ANC and three newborn health outcomes.

1. Late pregnancy losses (including fetal loss after 13 weeks of gestation and stillbirths )
2. Low birth weight infants (LBW), among live births[[1]](#footnote-1)
3. Perinatal mortality (stillbirth (fetal loss >=28 weeks of gestation) + early neonatal death (in the first 7 days after birth)

***Sensitivity analysis 1***

Gestational age at baseline (first ANC visit) was based on either the date of last menstrual period (LMP) reported by the pregnant woman or if LMP was also unknown, by the self-reported number of weeks pregnant. Given uncertainty in gestational ages at baseline, **analyses 1 and 3** will be repeated after excluding women with self-reported of number of weeks pregnant.

***Sensitivity analysis 2***

Birth weight was based on actual birth weight in kilograms (where LBW is defined as birth weight <2.5kg) reported by the mother. If actual weight was unknown, women were asked to report the baby’s size at birth (very large, larger than average, average, smaller than average and very small). We will repeat **analysis 2** in the subset for which birthweight was measured.

***Independent variable***

We will describe ANC utilization and create an index for the quality of ANC visits (**table 3**).

**Quality of the first ANC contact**

* Physical examinations
  + Blood pressure measured
  + Weight measured
  + Height measured
  + Mid-upper arm circumference (MUAC) measured
  + Fetal heat beat listening among those whose ANC1 at 2nd or 3rd trimester
* Diagnostic tests
  + Blood test (blood draw or finger prick)
  + Urine test
  + Ultrasound
* History taking and screening
  + Asked date of last menstrual period
  + Depression screening
  + Danger signs screening
  + Previous pregnancies discussed
* Counseling
  + Nutrition
  + Exercise
  + Estimated due date given
  + Told to return to ANC visit
  + Birth preparedness
  + Signs of pregnancy complications to look for
  + Counseling on stopping tobacco use among those who reported using tobacco
  + Counseling on stopping drinking alcohol among those who reported drinking alcohol
* Treatment and prevention
  + Iron and folic acid pills (given or prescribed)
  + Calcium supplements (given or prescribed)
  + Deworming medication (given or prescribed)
  + Tetanus toxoid vaccination (among those not already protected)

**Statistical analysis**

We will use separate regression models to assess associations between the ANC quality score in the first visit and, respectively, late pregnancy losses, LBW infants, and perinatal deaths.

The analysis for the association between ANC and fetal losses will be restricted to women who attended their first ANC visit in their first trimester since women already in second or third trimester are less likely to have a miscarriage since most of them have already passed the period most at risk for a miscarriage.

The analysis for the association between ANC quality and LBW will include all women. The analysis for perinatal mortality will be restricted to women in first and second trimester since the outcome stillbirth can occur during the third trimester (after 28 weeks).

All models will be adjusted for a series of potential confounders including demographic characteristics, health status, and presence of risk factors at baseline (described above).

We will also assess ANC quality score in three categories: receiving between 0 and 33% of recommended items, 34% to 66% and 67% to 100% of recommended care.

Models will include data pooled from all three countries and will include fixed effects for site, random effects for the facility where women were enrolled and robust standard errors.

**References**

1. Tekelab, T., et al., *The impact of antenatal care on neonatal mortality in sub-Saharan Africa: A systematic review and meta-analysis.* PLoS One, 2019. **14**(9): p. e0222566.

2. Wondemagegn, A.T., et al., *The effect of antenatal care follow-up on neonatal health outcomes: a systematic review and meta-analysis.* Public Health Rev, 2018. **39**: p. 33.

3. Berhe, T., et al., *Does quality of antenatal care influence antepartum stillbirth in Hossana City, South Ethiopia?* PLOS Glob Public Health, 2023. **3**(1): p. e0001468.

4. Ota, E., et al., *Antenatal interventions for preventing stillbirth, fetal loss and perinatal death: an overview of Cochrane systematic reviews.* Cochrane Database Syst Rev, 2020. **12**(12): p. Cd009599.

1. Birth weight was only assessed for babies still alive at the time of the survey. Therefore, this analysis will exclude neonatal deaths. [↑](#footnote-ref-1)