Trends and determinants of pregnancy loss in eastern Ethiopia from 2008 to 2019: analysis of health and demographic surveillance data

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Abstract
Background: Pregnancy losses remain a neglected issue and it will be taking more than a century before a pregnant woman in Sub Sahara has the same chance of her baby being born alive as a woman in a high-income country. Pregnancy loss data are limited and not universal in Sub Saharan countries. This study was aimed to assess the magnitude and determinants of pregnancy loss in eastern Ethiopia.

Methods: This study was conducted in, open continues and dynamic cohort of population, Kersa Health and Demographic Surveillance site (HDSS) in Eastern Ethiopia in 2008–2019. All mothers who had known pregnancy outcomes during the period and reside in Kersa HDSS were considered. The prevalence proportions were calculated as the sum of all pregnancy loss divided by the number births in the specified year. Log-Binomial regression was used to determine factors associated with pregnancy loss. Prevalence Proportion Ratio (PPR) was used to report the magnitude and strength of association. A p-value of less than 0.05 was considered statistically significant.

Results: From 39,153 included pregnancies, 810 (20.7; 95%CI:19.32, 22.15 per 1000 births) experienced pregnancy loss. Stillbirth was higher than abortion (11.14 Vs. 9.55 per 1000 births). Lacking own income (aPPR:1.26; 95%CI: 1.01, 1.58), being daily laborer (aPPR:1.44; 95%:1.08, 306), history of previous pregnancy loss (aPPR:2.26, 95%CI:1.69, 3.03), unwanted pregnancy (aPPR:1.26; 95%CI:1.01, 1.80), not receiving antenatal care (aPPR:1.59; 95%CI:1.19, 2.13) and not receive the TT-vaccine during pregnancy (aPPR:1.33; 95%CI: 1.08, 1.80) were positively associated with pregnancy loss.

Conclusions: The overall rate pregnancy loss was ranged between 19.32, 22.15 per 1000 births with higher still births than miscarriage or abortion. Pregnancy loss was positively associated with social factors reproductive health factors, and maternal health service utilization.

Keywords: Pregnancy loss, Stillbirth, Abortion, Miscarriage, Pregnancy outcome, Kersa HDSS, Ethiopia

Background
Pregnancy losses majorly include preterm birth, stillbirth, and low birth weight, which are the major cause of neonatal morbidity, mortality and long-term physical and psychological problems [1]. Pregnancy losses remain a neglected issue, invisible in policies and programs, underfinanced and in urgent need of attention [2]. Worldwide in 2015, for every 1000 total births, 18.4 babies were stillborn, mostly in low- and middle-income countries, and 160 years will pass before a pregnant woman in Africa has the same chance of her baby being born alive as a woman in a high-income country today [3–5].

These Adverse birth outcomes; prematurity, low birth weight, and stillbirth represent significant problems in
both developing and developed countries [6]. Each year, about 15 million babies in the world, more than one in 10 births, are born too prematurely [6, 7]. More than one million of those babies die shortly after birth; countless others suffer from lifelong physical, neurological, or educational disabilities, often at great cost to families and society [8, 9].

Among the 136 million babies born every year, approximately 2.6 million are stillborn. In 2006, 12% of babies are born prematurely, 8% with low birth weight, and 3% have major birth defects globally [10]. Recent report by UN indicated one stillbirth occurs every 16 s, and vast majority of stillbirths, 84%, occur in low- and lower-middle-income countries [11]. This report also indicated over 40% of stillbirths occur during labour. Therefore trends of pregnancy loss in one country could be the indicator for accessibility to maternal health care, and availability of professional birth assistance.

Pregnancy loss is global agenda as universal access to Sexual and Reproductive Health by 2030 is part of the Sustainable Development Goals [12]. In countries like Ethiopia where the preventive program “preconception care” has not yet been implemented, quantifying pregnancy loss and its predictors can help lay the groundwork for its introduction.

Several low- and middle-income countries (LMIC) use Demographic and Health Surveys and/or Health and Demographic Surveillance System to monitor the health of their population. From this surveillance, the regional disparities of pregnancy loss are evident, as the Sub-Sahara African region alone bears 66% of the burden [1, 10, 13].

Wide discrepancies were seen among previous reports on determinants of pregnancy loss and their importance in other Sub-Saharan African countries [14–17]. Meanwhile there are few studies focusing on the changes of incidence over the long period. Despite of requirement of evidence to show the trends and predictors of pregnancy loss there is scarce of published facts on the trends of pregnancy loss. We aimed to assess magnitude and determinants of pregnancy loss in eastern Ethiopia, from January 1, 2008 to December 31, 2019.

Methods

Study area

It was conducted in the Kersa Health and Demographic Surveillance Site (HDSS) in Eastern Ethiopia from January, 2008 to December 2019. Kersa HDSS is an open continues and dynamic cohort of population established in 2007. The surveillance started after conducting a baseline census in 2007 and followed by population update and event registration with house-to-house visits every 6 months. The catchment was established in 12 sub-districts of Hararghe district, Eastern Hararghe, Oromia Region, Ethiopia. The study site expanded to Harar town and encompasses 6 kebele in 2013. Both site (Kersa site and Harar site) doubled their study kebeles to 24 and 12 respectively in 2015. Currently Kersa HDSS is operating on 36 kebeles with 40,310 house holde. At the end of 2015, the population was 116,325. Until the end of 2015, 217,819 births and 4,475 deaths were registered respectively. Over 85% of births and deaths occurred at home. The annual net population growth ranges from -0.1 to 1.6. Meanwhile, the population growth rate ranged 1.63 to 2.94. The Total Fertility Rate ranges from 3.5 to 5.3 [18]. Khat, fruits and vegetables are important cash crops. Coffee is also an important cash crop; over 50 square kilometres are planted with this crop [19] (Fig. 1).

Study design and period

An open dynamic cohort study design that longitudinally follow a well-defined entity of primary subjects (individuals, households, and residential units) and all related socio-demographic and health-related outcomes within a clearly defined geographic area. We included event records (data) of women whose outcome of pregnancy was registered from January 2008 to December 2019.

Population and selection criteria

All mothers who had pregnancy outcomes during the period of January 2008 to December 2019 and reside in Kersa HDSS were considered as the study population. Data with incomplete with outcome variable were excluded from the study.

Sample size and sampling procedure

Researchers extracted 12 years (January 1, 2008-December 30, 2019) data from Kersa HDSS database system. All households with mothers who had ever pregnant and had pregnancy outcome during the study period were considered for health and demographic surveillance were considered. We extracted data of 39,153 women from the Kersa HDSS database for this analysis.

Data collection methods

Data were collected by well-trained regular Kersa HDSS staffs through face to face interview using tablet computer with Open Data Kit (ODK) collect application. The data collectors update the list of individuals living in the house during the 6-monthly field visits, by recording births, deaths and in- or out-migration. Changes in marital status through marriage, divorce, death of husband or wife or other separation are also recorded. Women are asked whether they were pregnant and about the pregnancy outcome. The economic status of individuals is
updated every 2 years and assessed in detail every 5 years. In addition to death registration for the deceased, verbal autopsies are taken from close relatives, typically after a mourning period of 45 days. Supervisors were assigned to supervise data collectors in the field. Field supervisors checked data quality before it was sent to the database system. If supervisors found a data quality problem, it sent back to data collectors for correction. Collected data using a tablet computer in the field was temporarily stored on ODK aggregate. The data manager approved the quality of data and migrated data from temporary storage to the final storage “Openhds” database system.

Variables and measurements

Outcome variable
Outcome variable of this study was pregnancy loss. Pregnancy losses are those pregnancy outcomes other than normal live birth which majorly includes preterm birth, stillbirth, and low birth weight which are the major cause of neonatal morbidity, mortality and long-term physical and psychological problems. In our study, pregnancy loss is referred to abortion, miscarriage or stillbirth. Both abortion and stillbirth were defined using a modified WHO criterion of fetal death [20, 21]. Abortion was defined as the deliberate termination of a human pregnancy, most often performed during the first 28 weeks of pregnancy. A miscarriage, or spontaneous abortion, is an event that results in the loss of a fetus before 28 weeks of pregnancy. On the other hand, stillbirth was defined as the birth of a baby who has died any time from 28 weeks of pregnancy through to the due date of birth. The baby may have died during the pregnancy or during birth. For analysis the pregnancy loss was classified as early (Miscarriage or abortion) and late pregnancy loss (stillbirth) [22].

Independent variables
We included sociodemographic (like age at first birth, level of literacy, occupation, household income, and
wealth index), fertility history (like number of pregnancies, number of births, pregnancy wanted, experience of previous pregnancy) and health care utilization history (like antenatal care and TT-vaccination) to assess pregnancy loss.

Statistical analysis
Data were described using means and standard deviations for continuous variables and rates and percentages for categorical data. Using an adaptation of the Delphi method, we developed shortened wealth indices (reclassified to three categories using the Kappa value). First, we recoded all categorical variables to binary variables. For questions with multiple response options, we recoded each response option as a binary variable (none were merged together). We removed response options with zero cases, as well as those common variables that were not included in the country-specific questionnaire. We then conducted a principal component analysis on all variables, with responses weighted at the individual level, and created a score from the factor weights of the first principal component. Scores were ordered and respondents were divided into 5 equal quintiles. Then we reclassified the quartiles in the lowest 2 quintiles, the middle quintile, and the highest 2 quintiles. The reclassification is deemed more programmatically meaningful, reliability as previous studies indicated [23].

The prevalence proportions were calculated as the sum of all pregnancy loss divided by the number of births in the specified year. The average annual percentage change in pregnancy loss (abortion and still birth) was calculated as \("\frac{a}{b}\times (1/r) - 1\) × 1000, where \(a\) defines the most recent (2019) pregnancy loss rate, \(b\) defines the earliest (2007) pregnancy loss rate and \(r\) defines the number of years, which for this analysis is 12 years. We summarize the trends of pregnancy loss with its 95% confidence interval. To determine the factors associated with pregnancy loss, we used the cumulative data for the years 2008 to 2019. Multivariate analysis using Log-Binomial regression was used to determine factors associated with pregnancy loss (stillbirth and abortion or miscarriage). The Log Binomial regression approach models the probability of having the outcome (pregnancy loss) based on the binomial distribution and the logarithm of the probability as the link function in a generalized linear model [24, 25]. Log Binomial regression was chosen over Cox and robust Poisson regressions for three reasons. First the Cox regression produced standard errors that were too large, whereas the log-binomial model and the robust Poisson model had the correct type I error probabilities. Second, robust Poisson regression overestimate the parameters, whereas it was not happened with the log-binomial model. Third, the Akaike information criteria (AIC) was minimum in Log Binomial regression. We used backward elimination method to select variables; include variables with p-value less than 0.2 in binary negative binomial regression into final model. Model goodness of fit was checked by “countfit” of stata package. Count fit of stata package is used to compare count model and includes prediction value, person chi square (for goodness of fit test) and other information criteria (AIC and BIC) [26]. Prevalence Proportion Ratio (PPR) was used to report the magnitude and strength of association. In this study reporting PPR was deemed more appropriate than reporting odds ratio (OR) due to considerable “overestimation” of the strength of the association by OR [27, 28]. A p-value of less than 0.05 was considered statistically significant. All data were analyzed using STATA v.16.0.

Results
Participant’s characteristics
Data of 39,153 women who had pregnancy outcomes since January 2008 and before January 2020 were employed for data analysis. Median (IQR) age of women was 27.87 (9.94) years and range from 13.13 to 48.96 years. Majority of the respondents were Oromo (89.85%) and Muslims (91.03%). Regarding educational level, more than half (63.96%) of the women neither read nor write and 34.19% were literates. Of the total, 30,636 (78.25%) were housewives and only 1,403 (3.58%) were employed. More than half (66.65%) of the respondents have their own income and 33.68% were found in first quintile of wealth index (Table 1).

Median (IQR) age at first birth was 18.52 (2) years. The minimum and maximum age at first birth was 13 and 30 respectively. For women who gave birth previously, 30,533 (77.98%) preceding children was alive while 865 (2.21%) died. Mean (± SD) number of pregnancies was 3.72 (2.36), 7,758 (19.88%) were first pregnancy. Mean (± SD) number of alive births was 2.17 (0.87) per women. During pregnancy, only 12,437 (31.77%) women were received antenatal care and 2,743 (35.65%) received tetanus toxoid vaccine. Participants characterized is summarized in Table 1.

Trends of pregnancy loss
From 39,153 pregnancies from 2008 to 2019, 436 (1.11%) resulted in still birth and 374 (0.96%) miscarriage or abortion. A larger number of births (5,591/39,153), abortion (83/384), and stillbirth (97/436) were recorded in 2017. Total still birth and abortion rates were 11.14 per 1000 births (95%CI: 10.14, 12.22) and 9.55 per 1000 births (95%CI: 8.64,
The percentage of pregnancy loss was increasing over the years and the highest pregnancy loss was recorded in 2015 (Fig. 2). The average annual decline rate in the overall pregnancy loss rate was 4.10%. Still birth takes the highest size of pregnancy loss and responsible for the increased trend of pregnancy loss. Overall, the rate of pregnancy loss was 20.7 per 1000 births (20.69, 95%CI:19.32, 22.15). Pregnancy loss was higher among mothers who did not receive antenatal care and not receive tetanus toxoid vaccine. Proportion of pregnancy loss was higher among women whose occupation was a daily laborer. Both abortion and stillbirth outcome were lower among women with formal education, daily laborer and women from household with poor wealth quintile (Table 2).

Table 1  Characteristics of women who ever gave birth between 2008 and 2019 in Kersa DHS site, eastern Ethiopia

| Variables                      | Frequency | Percentage |
|--------------------------------|-----------|------------|
| Ethnicity                      |           |            |
| Oromo                          | 35,171    | 89.85      |
| Amhara                         | 2,521     | 6.44       |
| Somali                         | 80        | 0.20       |
| Gurage                         | 671       | 1.71       |
| Harari                         | 501       | 1.28       |
| Tigre                          | 90        | 0.23       |
| Other                          | 112       | 0.29       |
| Religion                       |           |            |
| Muslim                         | 35,642    | 91.03      |
| Orthodox Christians            | 3,121     | 7.97       |
| Others                         | 390       | 0.99       |
| Education                      |           |            |
| Formal education               | 13,350    | 34.19      |
| Read only                      | 216       | 0.55       |
| Read and write                 | 509       | 1.30       |
| Can’t read and write           | 24,976    | 63.96      |
| Occupation                     |           |            |
| Housewife                      | 30,636    | 78.25      |
| Student                        | 2,506     | 6.40       |
| Unemployed                     | 1,922     | 4.91       |
| Employee                       | 1,403     | 3.58       |
| Farmer                         | 1,013     | 2.59       |
| Trader                         | 878       | 2.24       |
| Daily laborer                  | 502       | 1.28       |
| Others                         | 293       | 0.75       |
| Have own income                |           |            |
| Yes                            | 26,097    | 66.65      |
| No                             | 13,056    | 33.35      |
| Wealth Index                   |           |            |
| First quintile                 | 10,847    | 33.68      |
| Second quintile                | 11,987    | 33.49      |
| Third quintile                 | 12,506    | 34.94      |
| Number of pregnancies          |           |            |
| One                            | 7,758     | 19.81      |
| Two - Five                     | 22,473    | 57.40      |
| Six - Ten                      | 8,118     | 20.73      |
| More than 10                   | 804       | 2.05       |
| Preceding child alive          |           |            |
| Yes                            | 30,530    | 77.98      |
| No                             | 865       | 2.21       |
| First pregnancy                | 7,758     | 19.81      |
| Number of alive children       |           |            |
| One                            | 6,812     | 17.40      |
| Two - Five                     | 22,619    | 57.77      |
| Six - Ten                      | 7,795     | 19.91      |
| More than 10                   | 1,927     | 4.92       |

Predictors of pregnancy outcome
In Log-Binomial multivariate, pregnancy loss was significantly associated with having one’s own income, occupation, previous pregnancy experience, pregnancy wantedness, receiving antenatal care and receiving TT-vaccine (Table 3).

Women who did not had their own income were associated with a higher pregnancy loss (aPPR: 1.26; 95%CI: 1.01, 1.58) compared to mothers who have their own income. Compared to housewives, the proportion of pregnancy loss was higher by 44% (aPPR: 1.44; 95%: 1.08, 306) among daily laborer women. The proportion of pregnancy loss was more than two (aPPR:2.26, 95%CI: 1.69, 3.03) times higher among women whose preceding child was not alive. On the other hand, the proportion of pregnancy loss was higher by 26% (aPPR: 1.26; 95%: 1.01, 1.80) among women with unwanted pregnancy than that of wanted pregnancy. Compared to women who attend antenatal care, the proportion of pregnancy loss was higher by 59% (aPPR:1.59; 95%: 1.19, 2.13) among women who did not receive antenatal care. Similarly, women who did not receive the TT-vaccine during her pregnancy was associated with a higher pregnancy loss rate (aPPR:1.33; 95%: 1.08, 1.80) (Table 3).

Discussion
The overall rate pregnancy loss was just above 20 per 1000 births and sharply increased between 2012 and 2015 then became irregular up to 2019. Pregnancy loss was absolutely related to social factors (including haven’t own financial income and being daily laborer), and pregnancy experience (including unwanted pregnancy, previous pregnancy not alive). However negatively associated
with prenatal services (ANC, and TT vaccine) exposure of the mothers.

Pregnancy loss was more common among women without their own sources of income. Previous study conducted in Republic of Korea indicated the low income level is related to any negative pregnancy outcome [29]. Mothers who generate self-income are reported to have more power to make decision on family planning, and other maternal health service utilization [30].

Women who worked as daily laborers had a greater odd of pregnancy loss than housewives. Although it is difficult to draw strong conclusions, because they tend to be retrospective and confounded by alternatives, occupation can affect the pregnancy in different ways. One reason of pregnancy loss among daily laborer might be from occupational and environmental exposures like smoking, alcohol, and caffeine-have [31, 32]. The other cause might occupational hazardous or accidents as daily laborer are expected to lift heavy materials. Studies strengthen this evidence by reporting daily laborer women are working marginal, casual jobs with little regulatory protection, they hustle from engagement to engagement, typically for as little pay or as many hours the boss wants [33, 34]. Hence the long working hours and physical exertion, likely affect obstetric outcomes.

Prior pregnancy loss appears to increase the likelihood of subsequent pregnancy loss. This suggests a potentially inheritable component. Review conducted in 2009 reported significant number of pregnancy loss was associated with a parental balanced structural chromosome rearrangement, chromosomal inversions, insertions, and mosaicism [35]. The repeated pregnancy loss could be due to anatomical [36], environmental [31], endocrine [31], thrombotic [37] or distress and behavioral [38] etiologies.

Not attending antenatal care and not receiving TT-vaccine remained associated factors for pregnancy loss. Different studies evident antenatal care decrease pregnancy and birth complications by increasing the access to essential micronutrient supplementation, screening and treatment for complications, immunization against tetanus and insecticide-treated mosquito nets to help prevent this debilitating and sometimes deadly disease [39, 40].

This research has a number of advantages over previously reported results in Ethiopia. The first advantage is that we used the large surveillance data which was collected over wide range of years. This depicts the prevalence of pregnancy loss in the area. The model used to determine predictors is the second strength. By avoiding overestimation, the Log Binomial regression reduces the number of voices in the data. Our research,
on the other hand, is not without limitation. Possible clinical risk factors like uterine or cervical problems, diabetes, hypertension disorder and epilepsy were not included in this study’s findings. Behavioral factors including obesity, smoking, chewing Khat, alcohol, illicit drugs and medication were not included in this analysis. Despite these limitations, we included socio-economic and health-care data, as well as the trajectory of pregnancy loss. As a result, the results should be viewed with those limitations in mind.

### Conclusion

In conclusion, pregnancy loss was increasing over the last five years (2015–19) and positively associated with low own low socioeconomic status and adverse pregnancy experience. But negatively associated with antenatal services (ANC, and TT vaccine) exposure of the mothers. Therefore, to improve pregnancy outcomes in low-socioeconomic women, fundamental support to receive more prenatal care or to modify lifestyle risk factors, such as long working hours, may be needed in addition

### Table 2  Rate of pregnancy loss among women who gave birth during 2008-2019 by different characteristics of the women

| Variables       | Pregnancy loss | Pregnancy loss rates (per 1000) | Chi.2 |
|-----------------|----------------|---------------------------------|-------|
|                 | Yes            | No                              |       |
|                 | Early PL       | Late PL                         |       |
| Education       |                |                                 |       |
| Neither read nor write | 524            | 24452                           | 5.46 (4.63, 6.45) | 6.68 (5.69, 7.84) | 0.73 |
| Formal education| 271            | 13079                           | 5.09 (4.01, 6.46) | 7.81 (6.31, 9.67) |
| Read or write   | 13             | 712                             | 6.78 (2.83, 16.19) | 2.71 (0.68, 10.78) |
| Occupation      |                |                                 |       |
| Housewife or farmer | 675            | 30,974                          | 5.80 (5.03, 6.70) | 7.05 (6.11, 8.12) | 20.76* |
| Employed        | 16             | 1387                            | 2.77 (1.04, 7.37) | 4.85 (2.31, 10.14) |
| Unemployed      | 84             | 4344                            | 3.59 (2.20, 5.85) | 6.28 (4.34, 9.09) |
| Daily laborer   | 13             | 489                             | 3.9 (0.10, 15.65) | 13.75 (5.94, 31.52) |
| Trader          | 9              | 869                             | 1.09 (0.15, 7.70) | 5.43 (1.93, 15.25) |
| Others +        | 13             | 220                             | 13.56 (5.07, 35.77) | 16.95 (7.03, 40.28) |
| Has own income  |                |                                 |       |
| Yes             | 500            | 25,597                          | 9.08 (8.00, 10.32) | 10.078 (8.94, 11.36) | 9.03* |
| No              | 310            | 12,746                          | 10.49 (8.88, 12.39) | 13.25 (11.43, 15.36) |
| Wealth Index    |                |                                 |       |
| First quintile  | 281            | 10,566                          | 12.45 (10.52, 14.71) | 13.46 (11.46, 15.81) | 9.52* |
| Middle quintile | 236            | 10,979                          | 10.25 (8.55, 12.30) | 10.79 (9.04, 12.88) |
| Third quintile  | 209            | 9,934                           | 9.07 (7.40, 11.11) | 11.54 (9.63, 13.81) |
| Preceding Child alive | 526       | 30,007                          | 8.45 (7.48, 9.54) | 8.78 (7.79, 9.89) | 55.64* |
| Yes             | 520            | 29,007                          | 19.49 (15.256, 24.87) | 30.32 (24.94, 36.83) |
| No              | 220            | 10,979                          | 19.49 (15.256, 24.87) | 30.32 (24.94, 36.83) |
| First pregnancy | 64             | 2,506                           | 10.51 (7.21, 15.28) | 14.39 (10.45, 19.81) |
| Number pregnancy|                |                                 |       |
| One             | 188            | 7,570                           | 9.41 (7.49, 11.82) | 14.82 (12.36, 17.77) |
| Two -Five       | 441            | 22,032                          | 9.70 (8.49, 11.07) | 9.92 (8.71, 11.31) |
| Six -Ten        | 166            | 7,952                           | 9.24 (7.37, 11.57) | 11.21 (9.14, 13.75) |
| More than 10    | 15             | 789                             | 9.95 (4.98, 19.78) | 8.71 (4.15, 18.15) |
| ANC             |                |                                 |       |
| Yes             | 197            | 12,240                          | 4.18 (3.19, 5.48) | 11.66 (9.92, 13.70) | 64.72* |
| No              | 613            | 26,103                          | 12.05 (10.81, 13.43) | 10.89 (9.72, 12.21) |
| Vaccinated TT- during | 93             | 8,071                           | 3.67 (2.57, 5.25) | 7.72 (6.03, 9.87) | 67.42* |
| Yes             | 717            | 30,272                          | 11.10 (9.99, 12.33) | 12.04 (10.88, 13.31) |
| No              |                |                                 |       |

+ others include students, retired, PL: Pregnancy loss, Chi.2 Chi-square value

*: p-value < 0.05
to lowering the problem of pregnancy loss. This finding suggests that the health policy and programs should not solely concentrate on the enhancement of adequate prenatal care. Instead, there is a need for social interventions aimed at more in-depth and distal determinants of health to improve pregnancy outcomes in pregnant women.

### Abbreviations

AIC: Akaike information criteria; ANC: Antenatal care; TT: Tetanus Toxoid; HDSS: Kers Health and Demographic Health Surveillance Site; LMIC: Low-and Middle-income countries; PPR: Prevalence Proportion Ratio; IRB: Institutional Review Board; IQR: Inter quartile range; SD: Standard deviation.

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### Table 3  Factors associated with pregnancy loss in Kersa HDSS from 2007 to 2019, Eastern Ethiopia

| Pregnancy loss | No (%) | Yes (%) | cPPR (95%CI) | aPPR (95%CI) |
|----------------|--------|---------|--------------|--------------|
| **Education**  |        |         |              |              |
| Have formal education | 13079 (97.97) | 271 (2.03) | 1 | 1 |
| Read or write | 712 (98.21) | 13 (1.79) | 0.88 (0.51, 1.53) | 1.11 (0.52, 2.37) |
| Can’t read and write | 24452 (97.9) | 524 (2.1) | 1.03 (0.89, 1.20) | 0.99 (0.78, 1.26) |
| **Having own income** |        |         |              |              |
| Yes | 25597 (98.08) | 500 (1.92) | 1 | 1 |
| No | 12746 (97.63) | 310 (2.37) | 1.24 (1.08, 1.43) | 1.26 (1.01, 1.58) * |
| **Wealth index** |        |         |              |              |
| Poor | 17428 (97.94) | 367 (2.06) | 1 | 1 |
| Middle | 10981 (97.91) | 234 (2.09) | 1.01 (0.86, 1.19) | 1.18 (0.91, 1.53) |
| Rich | 9934 (97.94) | 209 (2.06) | 1.00 (0.84, 1.18) | 1.20 (0.91, 1.57) |
| **Occupation** |        |         |              |              |
| Housewife | 30974 (97.87) | 675 (2.13) | 1 | 1 |
| Employee | 2534 (98.45) | 40 (1.55) | 0.73 (0.53, 1.00) | 0.78 (0.46, 1.32) |
| Unemployed | 4346 (98.15) | 82 (1.85) | 0.87 (0.69, 1.09) | 0.83 (0.59, 1.17) |
| Daily laborer | 489 (97.41) | 13 (2.59) | 1.21 (0.71, 2.09) | 1.44 (1.08, 3.06) * |
| **Age at first birth** |        |         |              |              |
| Under 18 years | 8697 (98.3) | 150 (1.7) | 1 | 1 |
| 18–25 years | 27257 (97.82) | 608 (2.18) | 1.29 (1.08, 1.54) | 1.06 (0.81, 1.39) |
| > 25 years | 2389 (97.87) | 52 (2.13) | 1.26 (0.92, 1.72) | 1.16 (0.69, 1.93) |
| **Previous birth alive** |        |         |              |              |
| Yes | 32766 (98.25) | 585 (1.75) | 1 | 1 |
| No | 3071 (95.02) | 161 (4.98) | 2.84 (2.39, 3.37) | 2.26 (1.69, 3.03) ** |
| First Pregnancy | 2506 (97.51) | 64 (2.49) | 1.42 (1.10, 1.83) | 0.81 (0.52, 1.26) |
| **Pregnancy wanted** |        |         |              |              |
| Yes | 10,716 (98.11) | 206 (1.89) | 1 | 1 |
| No | 4052 (96.87) | 131 (3.13) | 1.66 (1.34, 2.06) | 1.26 (1.01, 1.58) * |
| **Number of pregnancies** |        |         |              |              |
| One | 22,000 (97.9) | 473 (2.1) | 1 | 1 |
| two -five | 7973 (98.21) | 145 (1.79) | 0.92 (0.78, 1.09) | 0.97 (0.73, 1.30) |
| Six-ten | 789 (98.13) | 15 (1.87) | 0.78 (0.63, 0.97) | 0.95 (0.66, 1.37) |
| More than ten | 22,000 (97.9) | 473 (2.1) | 0.82 (0.49, 1.38) | 0.89 (0.36, 2.22) |
| **Receive TT vaccine** |        |         |              |              |
| Yes | 8055 (98.66) | 109 (1.34) | 1 | 1 |
| No | 30288 (97.74) | 701 (2.26) | 1.69 (1.39, 2.07) | 1.33 (1.08, 1.80) * |
| **Received antenatal care** |        |         |              |              |
| Yes | 12212 (98.19) | 225 (1.81) | 1 | 1 |
| No | 26131 (97.81) | 585 (2.19) | 1.21 (1.04, 1.41) | 1.59 (1.19, 2.13) ** |

*APPR: Adjusted prevalence proportion ratio; cPPR: Crude prevalence proportion ratio; CI: Confidence Interval; TT: Tetanus Toxoid
Authors’ contributions
LDR develop concept, analyze data, write manuscript and was a major contributor in writing the manuscript. AT participate in proposal development, manuscript writing. GD and MD participate in data curation and statistical analysis. MD supervise overall study process and provide data. All authors critically revise manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
The data that support the findings of this study are available from Hararge Health and Demographic Surveillance office, but restrictions apply to the data use it for research purposes. To ensure data confidentiality, the data were with the Declaration of Helsinki and other relevant guidelines. Permission for publication was obtained from the IRB at Haramaya University. During primary data collection, informed consent was obtained from all subjects aged 18 or above years and legal guardian(s) of under eighteen. Verbal assent was also obtained for under eighteen children. All methods were performed in accordance with the with the Declaration of Helsinki and other relevant guidelines. Permission from the Hararge HDSS coordinator was received to access the data and use it for research purposes. To ensure data confidentiality, the data were exported without identifying information, such as the name or phone number.

Consent for publication
Not applicable.

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

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