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Time to initiation of Antenatal care and its predictors among pastoral pregnant women in madawalabu district public health facilities, southeastern Ethiopia, 2024: retrospective follow-up study

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ABSTRACT

Background: Timely initiation of antenatal care within the first trimester is critical for reducing maternal morbidity and mortality through early detection of complications and provision of key preventive interventions. Pastoralist communities, however, face substantial geographic and sociocultural barriers that may delay antennal care initiation, and empirical evidence on these determinants remains limited.

Objective: To assess time to initiation of antenatal care and its predictors among pastoral pregnant women in Madawalabu district, southeastern Ethiopia.

Methods: A facility-based retrospective follow-up study was conducted among 475 pregnant women who received antenatal care services at public health facilities in Madawalabu district in 2024. Participants were selected using systematic random sampling. Data were collected using checklists and structured interviewer-administered questionnaires, entered into Epi-Data 4.6.0, and analyzed with Stata 15. Time to first ANC contact was estimated using Kaplan–Meier survival analysis with log-rank tests. Predictors of antenatal care initiation were identified using Cox proportional hazards regression; model adequacy was assessed using Cox–Snell residuals.

Results: The mean survival time to antenatal care initiation was 7.4 months (95% CI: 7.08, 7.76). Earlier initiation was independently associated with higher maternal education (AHR = 1.65; 95% CI: 1.21, 2.25), urban residence (AHR = 1.96; 95% CI: 1.07, 3.59), having received counseling on antenatal care (AHR = 3.17; 95% CI: 1.18, 8.54), and good knowledge of antenatal care (AHR = 1.64; 95% CI: 1.14, 2.36). Longer delays were observed among women from female-headed households (AHR = 0.46; 95% CI: 0.26, 0.81) and those with no prior exposure to obstetric ultrasound scans (AHR = 0.12; 95% CI: 0.04, 0.32).

Conclusion and recommendation: Pregnant women in this pastoralist setting initiate antenatal care substantially later than World Health Organization recommendations. Educational attainment, place of residence, counseling, and antenatal care-related knowledge were predictors of earlier initiation, whereas female-headed household status and lack of prior ultrasound exposure contributed to delays. Targeted strategies including strengthening community-based health education tailored to pastoralist livelihoods, improving access in remote areas, expanding counseling services, supporting female-headed households, and promoting ultrasound use are urgently needed to improve timely antenatal care uptake.

Keywords: Antenatal care, time to initiation, predictors, pastoralist communities, Madawalabu district, southeastern Ethiopia.

INTRODUCTION

A positive pregnancy experience is a universal need and desire for all women, defined as a healthy pregnancy for the mother and her fetus, a good transition to safe labor and delivery, and good parenting (1). Pregnancy, though a natural process, is a critical life event when women and their babies are at heightened risk of morbidity and mortality(2). Antenatal care (ANC), according to the World Health Organization (WHO), is the routine care given by skilled health staff to pregnant women and adolescent girls to ensure the best possible health conditions for them and their babies during the antenatal period, from conception to the onset of labor(3). The WHO in its guidelines of 2016 recommended that all pregnant women should make their first antenatal care contact during the first trimester of pregnancy to enable timely detection and treatment of all existing and potential complications(4).

ANC assumes great importance to optimize maternal and fetal health outcomes(5). Early initiation of antenatal care allows for the delivery of key services such as treatment of iron deficiency anemia, tetanus toxoid injections to prevent neonatal tetanus, and treatment of maternal malnutrition (6).It also helps in the early detection and management of non-communicable diseases like diabetes, as well as counseling patients about modifiable aspects of their lifestyle, including smoking, alcohol, substance, obesity, and occupational hazards (7, 8).

Despite the improvements achieved worldwide, the rate of maternal death remains too high particularly in pastoralist area. WHO states that an estimated one death occurs every two minutes, and the maternal mortality rate in poor environments is 136 times higher than that in rich environments, with almost three-fourths of these deaths taking place in sub-Saharan Africa(9). WHO also states that the MMR in Ethiopia was 294 per 100,000 live births in 2019 and 267 in 2020(10). In the pastoralist zones of the country, 86% of maternal deaths are attributed to obstetric complications(11).The principal leading of maternal death in Ethiopia include hemorrhage, hypertensive disorders of pregnancy, unsafe abortion, and puerperal infections (12, 13).

The initiation of ANC services in a timely fashion varies across the globe and even in different regions of the world. It has been found that the global prevalence of the timely initiation of ANC services is 58.6%, in developing countries is 48.1%, while in high-income countries 84.8%(14). In Bangladesh, 11% (15).In Nigeria and Malawi,17% and 10% of women, respectively, receive

ANC in the first trimester (16). It has also been found that despite the Ethiopian Health Sector Transformation Plan II (HSTP II) setting the target of 81% coverage of ANC services by 2025, the national coverage of the initiation of ANC services increased from 26.7% in 2000 to 73.6% in 2019(17), but the Ethiopian Demographic and Health Surveys (EDHS) found that only 20% and 37.4% of pregnant women-initiated ANC services in the first trimester in 2021 and 2023 years respectively(18, 19).

In low- and middle-income countries, women begin ANC much later than in high-income countries. A pooled analysis from 54 countries reported that the median time to first ANC visit was approximately three months, with the highest proportions of timely initiation in Central and Southern Asia, and Latin America and the Caribbean (20). Country-specific studies have shown considerable variation, with median initiation times of four months in India(21), three to seven months in Pakistan(22), three months in Ghana(23), 18.3 weeks in Nigeria(24), and a mean of 6.8 months in Ethiopia(25).

Pastoralist pregnant women experience higher levels of marginalization, with very few access health care services(26, 27). In the pastoralist zone of Ethiopia, only one out of ten pregnant women received timely antenatal care (28). In the pastoralist zone, social factors, distance, transportation difficulties, preference for home delivery, preference for female health care providers, cultural factors, ignorance, factors associated with decision makers, health facilities, and disapproval of the spouse were among the barriers associated with the timely initiation of antenatal care (29, 30). Delays in the initiation of timely ANC have been associated with illness and death of both the mother and the fetus (6). The possibility of preventing or detecting complications, as well as the development of a plan of intervention of potential complications of pregnancy, may be missed (31). Increase risk of congenital syphilis, transmission of HIV/AIDS from the mother to the child, neural tube defects, risk of anemia, risk of preterm labor, IUFD, APH, and diabetes (32).

Despite, Ethiopia has invested heavily in maternal health services, including scale-up of primary care, incorporation of early ANC in the GTP II and district transformation strategies, scale-up of the workforce, free maternal care, health extension services, and the deployment of ambulance(33)e, the coverage of timely ANC is still low among the population, especially among pastoralists(27). The determinants of time to initiation of ANC among pastoralists are not well elucidated. Thus, this study set out to quantify the time-to-ANC initiation and the predictors, including the newly introduced variable of ultrasound imaging, among pregnant pastoral women attending public health facilities in the madawalabu district in 2024.

Study Design and setting

A facility-based retrospective follow-up study was conducted in the Madawalabu district of the Oromia region, in southeastern Ethiopia, in 2024. The Madawalabu district is part of the East Borena zone, which is characterized as a pastoralist zone. The district is bordered by the Ganale River to the south, which separates it from the Liban wereda, bordered by the West Arsi Zone in the northwest. In the north, it shares boundaries with Menna and Harena Buluk wereda, and with Guradamole in the northeast. Also shares boundaries with the Somali region in the east. The district administrative center, Bidire, is 684 kilometers from Addis Ababa, the capital of Ethiopia, and 90 kilometers from Negele Borena, the East Borena zone administrative center. According to the statistical office of Ethiopia, the district has a population of 140,893 as of 2023, with 70,540 men and 70,354 women (34). The district is served by seven public health institutions, including six health centers and one primary hospital. (See fig 1 for map of research area).

Population

All pregnant women who attended for antenatal care in public health facilities in Madawalabu district were source population were as all pregnant women who attended for their second to eighth antenatal care contact at public health facilities in Madawalabu district during study period were study population.

Inclusion and exclusion criteria

All pregnant women who attended for their second to eighth antenatal care contact at public health facilities in Madawalabu district during study period included in the study whereas pregnant women who had unknown gestational age at first contact for antenatal care were excluded from study.

Sample size and Sampling procedure

The sample size was computed based on the Schoenfeld statistical formula, taking into account the confidence level of 95%, the power of 80%, the ratio of the exposed to the unexposed of 1:1, and the proportion of withdrawal rate of 10%. The sample size of 475 was computed using STATA version 15 software, taking into account the Schoenfeld statistical formula, Hazard Ratio of the covariates associated with the time to antenatal care and the probability of the event occurring as 0.6264, based on the previous study conducted in Ethiopia (35) by running "power cox" command. Sample size required $(n) = \frac{\text{Total number of events (E)}}{\text{Probability of an event (PE)}} = n = \frac{E}{PE}$

This study was carried out in four public Health facilities. The study participants of each of the facilities were proportionally allocated after identifying six months report Antenatal care contact. The sampling interval was obtained after dividing the monthly attendance of ANC contact to determine the sample size. The sampling interval obtained was two. The sampling method used to recruit the pregnant women was the systematic random sampling method. The first pregnant women were selected through the lottery method. The selection of the pregnant women continued every two intervals until the predetermined sample size of the study was obtained. After selection, the pregnant women were interviewed and their corresponding card reviewed (see Fig. 2).

Data collection tools and methods

The study used a pretested structured data extraction checklist based on the Ethiopian Ministry of Health ANC register and an interviewer-administered questionnaire based on validated studies in Ethiopia(6, 25, 35-37). The questionnaire and checklist were first developed in English and then translated into Amharic and Afan Oromo.

The study used face-to-face interviewing in a private setting to collect sociodemographic information, health-related issues, ANC knowledge from the study population. Obstetrics history was extracted from facility medical records using the data extraction checklist. The study population was approached upon arrival at the ANC unit and interviewed before receiving care to avoid information bias.

Study Variables

Dependent Variable

The dependent variable of the present study was the time taken to initiate antenatal care. The time variable was defined as the period from the last normal menstrual period until the first contact of antenatal care. The time component of the present study was measured in months. The event of interest was defined as a 'success' if the women received the first contact of antenatal care during the first trimester of pregnancy(event=1). On the other hand, women who failed to receive ANC during the first trimester of pregnancy were defined as censored observation (event = 0).

Independent Variables

Sociodemographic and Socio-economic related factors: Mother's age, Marital status, Place of residence, Mother's educational level, Husband's educational level, Monthly family income, Media exposure, and Household head.

Factors related to the current pregnancy: Parity, Gravidity, Planned and unplanned pregnancy, means of identifying pregnancy, and birth interval.

Past obstetrics history related factors: History of child loss, History of abortion, Mode of delivery, Number of living children, Previous use of ANC services, Place of last birth, History of stillbirths, and Caesarean section history.

Health facility related factors: ANC waiting time, Ultrasound scanning, Health insurance coverage, and Distance to health facilities.

Knowledge of ANC service-related factors.

Operational definition

Time to initiation of antenatal care (time-to-event): It refers to the follow-up of time from the last normal menstrual period until the first antenatal care contact(38).

Event: The first antenatal care contact during the first trimesters of pregnancy (36).

Censored: A woman who made the first antenatal care contact after the first trimesters of pregnancy was considered censored (25).

Media exposure: Those women who responded at least once a week were considered as having regular exposure if they had listened to the radio, or if they had watched television, otherwise they were considered as having no median exposure (39).

Knowledge of pregnant women: It was measured using seven items, where "1" represents correct knowledge, whereas "0" represents incorrect knowledge. On the basis of modified Bloom's cut-off points, good knowledge was defined as scores >=80%, moderate knowledge as scores between 50% and 79%, and poor knowledge as scores below 50%(40).

Distance from health facility: When it takes more than 60 minutes to walk to the health facility, it is far, while if it can be reached within 60 minutes, it is near (41, 42).

Average family monthly income: This is obtained by dividing the income from all adults in a

given home by the number of households or adults who contribute to that income (37, 43).

Data quality control

The data Etraction checklist and questionaries were pre-tested among 24 study participants outside the study area. Errors, if any, were identified and rectified. Later on, some significant changes were made to improve the comprehensiveness and validity of the final version of the data extraction checklist and questionaries. The reliability was also tested for questions related to knowledge on antenatal care services, and it was found to be Cronbach's $\alpha = 0.804$. Questionnaires were first developed in English and then translated into Afan Oromo and Amharic languages, then back translated into English to ensure consistency. Training was also given to data collectors and supervisors before actual data collection. The training includes purpose of the study, data collection tool, methods, and ethical issues. During the actual data collection period, continuous monitoring was also conducted to ensure data quality. On each and every day of data collection, data collectors created a comfortable and open environment that helped them in having honest and informative interviews. Data was also examined for completeness and consistency. If any data was found to be ambiguous, confusing, and incomplete, it was discussed with respective data collectors, and appropriate correction was taken.

Data Processing and Analysis

The data was coded and entered into EpiData version 4.6 after the data collection process. To carry out more data cleansing, processing, and analysis, the data was exported to STATA version 15. Descriptive statistics were presented as tables, graphs, mean ± SD, frequencies, and percentages. Kaplan-Meier survival curve analysis was used to determine the probability of survival. To determine the difference in survival times between categories of categorical variables with relevant outcomes, the log-rank test was used. To determine the explanatory variables, Cox regression analysis was used. In the bivariate analysis, variables with a p-value of ≤ 0.25 were considered potential candidates for multivariable analysis. In the multivariable analysis, the backward stepwise approach was used, and variables with a p-value of < 0.05 were considered predictors of timely initiation of antenatal care. The Cox proportional hazard model assumption of validity was demonstrated using the Schoenfeld residual test. To determine the strength, the adjusted hazard ratio with its 95% CI was used. Model fit was also checked using

Cox-Snell residuals, and multicollinearity was checked for independent variables using variance inflation factors. Finally, results were organized and presented in the form of texts, graphs, tables, and charts.

Survival analysis

Survival analysis is a statistical analysis method that is used to analyze time-to-event data. The main focus of this method is to determine the time it takes for a given event to occur. The event of interest may be death, disease recurrence, or failure of the treatment (44).

Cox Proportional Hazards Model

Cox proportional hazards model is one of the most commonly used regression analysis techniques. It is used to examine the influence of different variables on the hazard or risk of the occurrence of the event of interest at a given time point (44).

The mathematical expression of the Cox model is as follows: $h(t)= ho(t)\cdot e^{(B_1x_1+B_2X_2+\ldots B_pX_p}$

In this expression, h(t) is the hazard function at time t. The hazard function is the probability of the occurrence of the event of interest at time t. The term ho(t) is the baseline hazard function. The term B1+B2+…+Bp represents the coefficients of each of the variables. The term x1+x2+…+xp represents the variables. The term e (B1x1+B2X2+…+BpXp) shows the influence of the variables on the hazard function**.**

The Cox proportional hazards model provides a summary of the effect of each covariate in terms of a hazard ratio, with values greater than 1 indicating increasing instantaneous risk with increasing covariate values, and values less than 1 indicating protective effects. However, since the Cox proportional hazards model is based on assumptions of proportional hazards, independence, and linear effects, researchers will check for violations of these assumptions by examining log-minus-log curves, plotting Schoenfeld residuals, and conducting a global test.

Ethical considerations

Clearance was obtained from the institutional review board (IRB) of Salale University, College of Health Science. A letter of cooperation from Salale University was sent to the Madawalabu Wereda Health Office, and permission was obtained from this office to conduct the research. Informed consent was obtained orally from the pregnant women after explaining the purpose of

the research. The participants were told that they had the right to refuse to participate in the research at any time. The participants were only involved in the research after obtaining their consent. The participants were told that all the data collected from them would be kept secret, and codes would be used instead of their names. The data collected would only be used for the purpose of the research.

Results

In this study a total of 458 women were involved with a response rate of 96.42%.

Sociodemographic and socioeconomic related factors

The mean age of respondents was 22 years (SD = 5.17). The majority, 41.27%, were aged between 20 and 24 years, with 29.31% of them initiating antenatal care in the first trimester. The highest initiation of antenatal care was in the 30-34 years age group, with 48%, while the least was in the 15-19 years age group, with 35.29%. The majority were married (88.21%), while 37.22% initiated antenatal care on time. The single women 29(3.28%), had a timely initiation rate of 9.09%, while for separated and widowed women, it was 4.17% and 10%, respectively. Nearly half, 47.60%, were from urban areas, with more than half, 53.52%, initiating antenatal care within the recommended time, while in rural areas, only 17.28% initiated antenatal care within the recommended time. The majority, 55.9%, were housewives, while only 17.83% initiated antenatal care within the recommended time. The government workers, with 15.28%, had an initiation rate of 79.41%, while for merchants, it was 43.07%. Unschooled individuals made up nearly one-fourth of the participants (24.89%), whereas 21.62% of the participants were found to have a college degree or above. Women with a college degree or above were found to have an ANC initiation rate of 81.25%. On the other hand, women without formal education were found to have a very low initiation rate (3.86%). Moreover, out of the pregnant women who were exposed to media outlets (65.28%) were found to be nearly half (47.29%) of the pregnant women had timely initiation of ANC. In comparison, out of the pregnant women not exposed to media (34.72%) were found to have only (6.8%). (See table 1).

Past and current obstetrics related factors

Closely half of the participants were primigravida women (46.51%), and 33.17% of them initiated ANC within the first trimester. Grand multigravida women made up 15.72% of the total participants, and 25.72% of them initiated ANC on time. Similarly, nulliparous women made up

46.51% of the total participants, and 38.81% of them initiated ANC within twelve weeks. On the other hand, grand multiparous women made up 9.61% of the total participants and had 31.81% initiating ANC on time. Of the total participants, 20.82% had lost their child, and only 14.28% of them had initiated ANC within three months compared to 40.10% of those who had not lost their child. Over three-quarters (77.41%) of the total women had never had an abortion, and 38.91% of them had initiated ANC within the first trimester. On the other hand, 22.59% of the total women had had an abortion, and only 22.2% of them had initiated ANC within the recommended time. Of the total women who had never had antenatal care in their previous pregnancy (32.14%), only 15.38% had initiated ANC within the first trimester. On the other hand, of the women with previous ANC experience (62.86%), almost half of the women (46.1%) had started ANC on time. Home delivery accounted for almost a quarter (24.90%) of the women, of whom only 9.8% had started ANC early. In contrast, of the women who had delivered at the facility (75.0%), 44.02% had started ANC on time. Of the women without previous cesarean experience, almost three-fourths (73.37%) had started ANC on time, compared with 67.69% of the women with previous cesarean experience (26.53%). Moreover, of the women with planned pregnancies (82.28%), the majority (57.18%) had started ANC on time, whereas only 24.69% of the women with unplanned pregnancies had started ANC on time. (See table 2).

Health service and ANC service knowledge related factors

Nearly half of the participants (48.47%) indicated that it takes more than one hour to access a healthcare facility, only 15.87% initiated their antenatal care (ANC) within the first three months of their pregnancy. Contrary to this, the majority of the participants (51.53%) indicated that it takes less than one hour to access a nearby health facility, and 70.34% initiated their ANC on time. While 50.66% of the participants had health insurance, nearly three-quarters (74.57%) initiated their ANC within the first trimester of their pregnancy. Contrary to this, nearly half of the participants (49.34%) had no insurance, and only 27.88% initiated their ANC within the first twelve weeks of their pregnancies. While fewer than half of the participants (45.45%) had undergone an ultrasound scan in their previous pregnancies, 87.50% of these participants initiated their antenatal care (ANC) within the recommended time. Contrary to this, only 29.17% of the participants who had not undergone a scan initiated their ANC on time. While only 17.65% of the participants with low knowledge (40.83%) initiated their ANC on time, 29.48% of the participants with intermediate knowledge (35.56%) initiated their ANC on time. Of the

participants with good knowledge (36.9%), the majority (91.72%) started ANC within the first three months (See table 3) and, responses of pregnant women regarding knowledge of antenatal care services (see figure 3) and, knowledge categories of ANC services for pregnant women (see figure 4).

Incidence and time to initiation of Antenatal care

The cohort of 458 women was followed for a period ranging from a minimum of 1 to a maximum of 10 months. It was observed that the timely initiation of antenatal care contact was 33.8% (95% CI: 29.5%, 38.2%). Additionally, the estimated mean (restricted) survival time for the pregnant women to initiate the first ANC contact was 7.4 months (95% CI: 7.08, 7.76), which corresponds to an overall incidence rate of 7 per 100 person-months of observation (95% CI: 6, 8). The total follow-up time provided by all the participants was 2198 person-months observations.

Overall Kaplan-Meier survival function and hazard function

Kaplan-Meier Survival Curve was used and generated to show the time to initiation of ANC. According to the curve, a significant number of expectant mothers did not start their ANC before the third month. The curve indicated a high rate of survival in the initial months, suggesting that expectant mothers were delaying the initiation of ANC. The curve decreased over time, suggesting that a large majority of expectant mothers started their ANC after three months. The findings suggested that over half of the expectant mothers did not start their antenatal care contacts by the end of three months. According to the Nelson-Aalen estimate of the cumulative hazard, the risk increases over time for pregnant women who start their antenatal care. About 99.56% of the pregnant women had yet to start ANC care at two months, and 70% had started ANC care at six months; over 82% of pregnant women had started ANC care at eight months (see fig.5).

Comparison of survival time for different groups of variables

Kaplan Meier Graphs were used for the analysis and observation of the differences in the time to first ANC contact for different categories of women. As depicted in figure 8 blow, the urban resident pregnant women (red line) have a lower survival probability than the rural ones (blue line) throughout the analysis period. This suggests that pregnant women who are residents in urban areas were likely to make earlier contact at the time of pregnancy than their rural

counterparts at a median time of 2.75 months and were statistically significant as depicted by the log rank test (90.95) and p-value (0.0001). Also, pregnant women who had no formal education had the highest survival probability than their counterparts, suggesting they were the least likely to make earlier contact than those who had college education and above, who had the least survival probability at a median time of just 2.5 months (CI: 2.25 to 2.56).

However, the time to the start of ANC for those who had not been counseled was longer. The statistical significance of the difference in the time to the start of ANC between the pregnant women who had been counseled and those who had not been counseled was assessed by the log-rank test statistic of 76.8 and the p-value of 0.0001. The pregnant women who had not been offered the ultrasonography scan during the previous pregnancy (purple line) took longer to start the antenatal care than the women who had been scanned (red line). The women who had been scanned had a reduced survival probability. The time to the start of the antenatal care for these women had a median of 2.5 months (95% CI: 2.5, 2.75). A statistically significant difference between the two groups of women was assessed by the log-rank test statistic of 160.64 and the p-value of 0.0001. (See figure 6).

Comparison of survival times using the Log-Rank test for equality across different covariates

To test for variations in survival experiences, log-rank tests were used. The findings on variations in survival experiences for various groups of categorical variables have been presented in table 4. The findings indicate that there is a significant difference in survival time for women's education level ($p < 0.0001$), media exposure ($p < 0.0001$), marital status ($p = 0.0107$), place of residence ($p = 0.0001$), occupation ($p = 0.0001$), experience of child loss ($p = 0.0006$), birth interval ($p = 0.0001$), place of last birth ($p = 0.0001$), experience of cesarean section ($p = 0.0001$), planned pregnancy ($p = 0.0001$), method of recognition of pregnancy ($p = 0.0001$), experience of counseling ($p = 0.0001$), distance to medical facilities ($p = 0.0001$), health insurance ($p = 0.0001$), experience of ultrasound scan for last pregnancy ($p = 0.0001$), women's knowledge of antenatal care services ($p = 0.0001$), and experience of being a household head ($p = 0.001$)(See table 4).

Predictors of the time to initiation of antenatal care among pastoral pregnant women

A cox proportional hazards regression analysis was carried out in the present study to identify the predictors of the time to start of antenatal care visits among pregnant pastoralists. The study used an initial bivariate analysis that considered 36 variables to select 23 candidates which achieved a p-value of <=0.25 for the multivariable analysis which had variables such as; resident, education of women and her partner, family monthly income, household head, women employment, number of children loss, previous birth intervals, number of previous antenatal visit, birthplace of pregnancy, whether a planned pregnancy, planned pregnancy involving her partner, method used for pregnancy diagnosis, antenatal visit counseling, proximity to health facilities, time the pregnant woman knew when to have ANC, health insurance coverage, median women exposure, waiting time to Antenatal care services, perception about waiting time, whether had a CS history, if she had been having ultrasound before and level of knowledge of the pregnant women about Antenatal care service; and these was fitted to backward stepwise multivariable cox regression model. In the final model and adjusted with significance level at $p<0.05$. six predictors were found to be significant such as: residency, women education, women employment, counseling for ANC visits and prior scan and level of knowledge of the pregnant women to ANC service.

In current study, the hazard of commencing the first ANC contact in pregnancy was 1.96 times shorter for urban women compared with women in the rural areas (AHR=1.96; 95% CI:1.07, 3.59). A college educated or higher women's time to initiation of first ANC contact was 65% shorter compared with women with no formal education (AHR=1.65; 95% CI:1.21,2.25). Being in self-headed rather than male-headed households took an additional 54% longer time to initiate ANC contact (AHR=0.46; 95% CI:0.26,0.81). Advice from healthcare professionals on commencement of ANC resulted in a 3.17 times shorter time to initiating first ANC contact than in women who received no advice (AHR=3.17; 95% CI:1.18,8.54). Women who had not had an ultrasound scan during their previous pregnancy had 88% longer time to initiating ANC contact than women who had (AHR=0.12; 95% CI:0.04,0.32). Moreover, knowledgeable pregnant women have 1.64 times as likely to initiate ANC services early compared with poorly knowledgeable women about ANC services (AHR=1.64; 95% CI:1.14,2.36). (See table 5).

Test of proportional hazard assumption

The proportional hazards assumption was tested using both statistical tests and graphical representations. The overall Schoenfeld residual test indicated no systematic time-dependent effects for the covariates tested, giving a chi-square statistic of 22 on 23 degrees of freedom with p-value = 0.5205 (see table 6). Graphical representation and consideration of plots of scaled Schoenfeld residuals versus time (See figure 7) shows that there is no significant departure from linearity, nor substantive curve crossing, as the curves maintain a parallel pattern over time. Both quantitative and visual analyses supported the assumption of proportionality in the Cox model holds true.

Multicollinearity Assessment

To examine multicollinearity between the covariates, the variance inflation factor was computed. The VIF was found to be 1.97, which is lower than the common cut-off points of 5. (See table 7).

Overall model adequacy

To evaluate the overall good fit for the Cox proportional hazards model, the Cox-Snell residual plot was constructed. The Cox-Snell residuals of a good fitting model follow a standard exponential distribution with mean 1. Thus, the points should closely follow the line of slope 45-degrees. The plot of the observed data points closely follows the 45-degree line. In general, the Cox-Snell residual plot provides good fit for the Cox proportional hazards model to this data set (see figure 8).

Discussion

The time of ANC initiation and factors that predict it were assessed in this study among pregnant women attending ANC services at public health facilities at Madawalabu district in 2024. Mean(restricted)survival time for pregnant women to get first ANC contact was 7.4 months(95%CI:7.09,7.75). Also, the time to ANC initiation was well predicted by women's educational status, residence, counseling, household status, and the antenatal care counseling, and previous obstetrics ultrasound scan.

Mean(restricted) time to ANC initiation was 7.4 months among this study participants. This finding is supported by study done in Uganda(45) and Ethiopian study (36) who stated the

median survival time was 7 months. The possible justification is might be use of almost the same methodology in the analysis. The mean survival time to first ANC contact in the current study was larger than those reported in the studies conducted in 54 African countries where median time was 3 months (46), in Ghana median time was 3 months(47), in India the median survival time to first ANC contact was 4 months (48), in Nigeria, which shows that media survival time to first ANC checkup was 18.3 weeks(24).

The plausible reason behind these variations could be; different study design, different size and duration of the follow up, study setting, the social and economic conditions of participants and the surrounding conditions of the health facility and accessibility/infrastructure of the facility. It was also larger than those reported in the previous studies from EDHS where mean survival time was 6.8 months (25) and in Arbaminch town Southern Ethiopia media survival time was 18 weeks(49). The disparity in these survival times to first ANC contacts could be attributed to difference in sample size and duration of follow up.

In this finding timely initiation of ANC within the first three month of pregnancy was found to be 33.8% (95%CI 29.5-38.2%). It is almost similar with a previous study carried out in Nigeria reported 33.9% pregnant women-initiated ANC within first trimester (50), in Guinea reported 33.5% (51), in southern Ethiopia reported 34.3%(52). On contrary, it is considerably higher when compared with a study in Bangladesh where only 11% received timely first ANC (15), in Nigeria where only 24% initiated ANC timely (53) and Malawi where only 10% pregnant women attended ANC within 12 weeks(16). Moreover, high as compared with a study in Afar, Ethiopia where 9.7% of women-initiated ANC timely (27).

The major reason that makes this study outstanding is the methodology it used which includes sophisticated statistical methods and longitudinal design, the diversity sample size and duration. Conversely, findings were lower than those of other studies conducted from Ethiopia demographic health survey results (25, 54). A possible clarification might be that these different results can be attributed to the specificity of pastoral community that the present study focused on. Cultural values and behaviors in pastoralist communities are often revolved around mobility and herd-grazing, which could limit women access to health services(55). Moreover, the health infrastructure of pastoralist areas may be minimal, resulting in fewer centers being available to deliver timeous ANC(56). Awareness among pastoralist pregnant women concerning the benefits

of early initiation, lack of funds, transportation and other access issues could also be barriers that affect pregnant women's timely initiation(26, 27, 30).

In the present study urban women are 1.96 times more likely to have an early initiation of ANC than rural women. This is supported by previous studies conducted in Nepal (57), Nigeria (31, 58), and Bangladesh(15). Equally, a study conducted in Uganda by Cox regression analysis revealed that women from the urban area were 1.9 times more likely to start their first contact early than women living in rural area (59). In Lesotho urban-dwelling women were three times more likely to start ANC faster than rural dwelling women(60). Likewise in South Africa, women in the urban area were 1.7 times more likely shorter than rural dweller to have started ANC(61). In addition, in Gahana it revealed that the hazard of urban woman in initiating of ANC visit was 1.5 times more likely sooner than rural dwellers (62). Furthermore, the finding is also consistent with Ethiopian studies showing the ANC initiation time was 18% later among rural dwellers compared to urban dwellers (35). Correspondingly, a study done in Arbaminch town South Ethiopia based on facility data indicated that time for initiating ANC is 2.67 times shorter among urban dwellers than rural dwellers(49). More so, comparable result were also seen in studies that were based on EDHS (25).

One explanation may be that women living in urban areas may have access to diverse media services and increased levels of education compared to women in rural areas, which may provide explanation to prompt ANC initiation(63).Women in urban areas face little difficulty accessing and receiving early ANC because of the ready accessibility of these services compared to women in rural areas where access may mean long travelling time to facilities and availability of limited choices (64). High literacy and higher income levels for women in urban areas mean that women will realize the necessity of early antenatal care as well as possess means and transportation for their access (65). Culture encouraging emphasis on prevention and women's health issues coupled with adequate social networks and effective health communication contribute to earlier antenatal care initiation (ANC) in women in urban areas (66). Rural women are not afforded maternal health care services because of lack of availability, cost, and access (67).

From our study, it was found that educational level was a significant factor of early initiated of pregnant women into ANC. The hazard of an educated woman entering into ANC early were 1.65 times higher than those with no education. This result agreed with conducted studies

conducted in India(48),Nepal(57),Bangladesh(15),Nigeria(43, 53),with EDHS Ethiopian data(25, 35, 36),Northern Ethiopia (68),Northwest Ethiopia (69),South Ethiopia(49).

The rationale for this association may be that educated women have improved capabilities, especially the capacity to acquire and utilize health services(70). It was found that educated women are likely to start ANC early, since they are able to access and comprehend the health information available in varied styles and ways(71). Education increased health literacy and ability to understand the need and priority of health care services (72). Furthermore, it increased the woman's ability to make her own health care choices and therefore, they themselves can decide about timing and manner of starting ANC depending on their knowledge of the issue (43, 70, 73).

Conversely, the present result shows that compared to male headed households, female-headed households were 54% more likely to initiate antenatal care late. This finding is inconsistent with previous study done in Ethiopia where women in male-headed households were twice more likely than their counterparts to have had a late first ANC contact (74). Differences in study finding might due to variations in sample size.

The possible explanation could be since decisions regarding healthcare often lie with the male household head women will often have to ask for permission and get a resistance from male family members based on gender assumptions(75). Female-headed households often face with limited resources which could limit access to health care facilities and hence late for start of ANC(76). Additionally, culture attitudes toward female household leadership also affect women’s health decisions and the internalized belief of not having control over their health care choices among women (77).

It was found that if the women had counseling for commencement of an ANC, the hazard of seeking the service increased 3.17 times. Possible justification is women who receive antenatal care counseling are more likely to access antenatal care services early due to increased awareness and associated health benefits such as early detection and positive effects on mothers and children(32). Counseling additionally helps in clarifying the dangers associated with delayed health seeking which in turn influences women's readiness in adopting health seeking behaviors early in pregnancy. Moreover, social support from health professionals and families strengthens such behavior, while practical methods are provided in overcoming practical barriers such as

transportation or economic hardships (78). Counseling also strengthens women's motivation to make healthy choices as they become more confident in managing their health needs through support from the providers (8).

Moreover, ultrasound scanning was found to be predictor of time to initiation of ANC contacts. The outcome indicated that compared to pregnant women scanned for ultrasound for previous pregnancy, those who had no ultrasound scans for the previous pregnancy were 88% more likely to delay timely ANC contacts initiation. This can be due to the fact that ultrasound scanning contributes to increasing women's knowledge regarding pregnancy health-related issue and scan for previous pregnancy indicates women were more knowledge of timely ANC and routine checkups need for pregnancy and this usually contributes to increased health seeking behaviors (79). The results that scan for pregnancy in previous pregnancy helps the pregnant women to be aware of risk on pregnancy health and the visually of the scans in ultrasound helps the woman to make the pregnancy tangible and be more conscious to initiate early ANC contact, and women who see their developing fetus during an ultrasound scan are often more emotionally invested in their pregnancies and therefore more proactive about monitoring their health and are more likely to talk to other pregnant women about the importance of the care that can give rise to positive pregnancy health outcomes(80).

Finally, pregnant mothers with good knowledge of ANC service had a 64% increased the hazard of early initiation of ANC than mothers with poor knowledge of ANC service. This is consistent with studies from South Gonder, Ethiopia, where women with poor ANC knowledge were about 3 times more likely to be late for ANC contact than women with good knowledge (81). It is also in line with the study of Hossana, Ethiopia, where pregnant women with good ANC service knowledge had 3.1 times increased the hazard early initiation of ANC compared to pregnant women with poor ANC service knowledge(52). The similarity between finding may be attributed to similar cultural beliefs and traditions that lead the pregnant women towards a good knowledge of ANC service and similar health system and guidance that have the same impact on pregnant mothers. Possible explanation for this may be that the pregnant mothers who had good knowledge of ANC service might use it early because the pregnant women might know the knowledge related to the care of pregnant women better which make them more likely to accept the early antenatal care service (52).

Study limitations and strength

Several limitations should be noted with regards to this facility based retrospective study. It is susceptible to recall and social desirability bias. This facility-based nature of study may also exclude significant community-based factors in care seeking behaviors. Despite the limitations, this study has contributed significant findings. To our knowledge this is the first to evaluate the timeliness of initiation of ANC in pastoralist settings in this region. This provides an essential baseline upon which to build on in future studies. The study has also incorporated primary and secondary data, as well as both hospitals and health centers in a bid to improve the study's internal validity and increase the generalizability of the findings to similar settings. Crucially, the study is one of the first to analyze the relationship between prior obstetric ultrasound services and the initiation of ANC, yielding novel and programmatically important results.

Conclusion

The current study discovered that the mean(restricted) time to commence ANC was 7.4 months, which was longer than recommended by WHO. Residence in an urban area, higher educational status, a good knowledge of ANC services, and availability of counseling services all shorter the time it took to commence ANC. Not having had an ultrasound scan in the previous pregnancy and female household head were associated with an increased time to initiate ANC.

Recommendations:

Health workers: counsel appropriately about early ANC and advocate for obstetric ultrasound as indicated.

Health extension workers: provide timely home-based education and ensure a referral system exists at facilities with an obstetric ultrasound.

Researchers: conduct longitudinal, community-based research to identify determinants of early initiation of ANC.

NGOs: Run culturally specific, health education outreach programs for rural, low literacy women, support counseling services, and fund provider training in obstetric ultrasound.

Madawalabu District health facilities: Ensure well trained ANC counselors are on hand, ensure ultrasound providers are competent, conduct outreach to mobile pastoralist communities,

conduct health facility outreach and events with community leaders, and extend clinic hours to cater for the needs of female headed households.

Madawalabu District Educational Bureau: work with universities to increase the chances of pastoralist girls accessing university education, work with community leaders and the media, and initiate mentoring programs for students entering university

Acronyms and Abbreviations

AOR: Adjusted Odds Ratio

APH: Antepartum Hemorrhage

ANC: Antenatal Care

EDHS: Ethiopian Demographic and Health Survey

GTP II: Growth and Transformation Plan two

HSTP: Health Service Transformation Plan

IUFD: Intra Uterine Fetal Death

MMR: Maternal Mortality Rate

NMR: Neonatal Mortality Rate

Declaration

Data sharing statement

The data for this work cannot be made available at the current time. It will be available to be requested with realistic need from the corresponding author.

The data supporting

Contributors

Alemayehu Guta Tulu; designed and coordinated the study, developed the research protocol, performed the statistical analysis and interpreted the findings and drafted the manuscript. Then he critically reviewed the manuscript. Fikadu Tolosa Alamu, and Tasfaye Oyato: designed the study, assisted in statistical analysis and critically reviewed the manuscript. Mulugeta Feyisa; principal supervision of the study, participated in the design and coordination of the study.

Alemayehu Guta Tulu: has final responsibility for the content, takes responsibility to guarantee that the data can be accessed, and will make final decision to publish. All authors read and approved the final manuscript.

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Competing interests

None declared.

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Table 1. Sociodemographic and socioeconomic factors related to time to Antenatal care initiation in madawalabu district public Health facilities,2024.

			Time to Antenatal care initiation	
Variables	Categories	Total (%)	Event N (%)	Censored N (%)
Age	15-19	114(24.89)	41 (37.17)	73 (62.83)
	20-24	189 (41.27)	56 (29.31)	133 (70.69)
	25-29	113(24.67)	41 (36.36)	72 (63.64)
	30-34	25 (5.46)	11 (48)	14 (52)
	>=35	17(3.71)	6 (35.29)	11 (64.71)
Marital status	Single	15(3.28)	3(9.09)	12(90.91)
	Married	404(88.21)	148(37.22)	256(62.78)
	Separated	29(6.33)	3(4.17)	26(95.83)
	Widowed	10(2.18)	1(10)	9 (90)
place of residence	Rural	240(52.40)	33(17.28)	107(82.72)
	Urban	218(47.60)	122(53.52)	96(46.47)
Occupation of the Women	House wife	256(55.90)	44(17.83)	213(82.17)
	Merchant	132(28.82)	56(43.07)	76(56.93)
	Government employee	70(15.28)	55 (79.41)	15(20.59)
educational Level of the women	No formal	114(24.89)	2(3.86)	112(96.14)
	Primary	185(40.39)	36(26.54%)	149(73.46)
	Secondary	60(13.10)	32(57.14)	28(42.86)
	College and above	99(21.62)	85(81.25)	14(18.75)
Husbands level of Education	No formal	112(26.92)	9(4.31%)	103(95.69)
	Primary	170(40.87)	48(28)	122(72)
	Secondary	67(16.11)	39(60)	28(40)
	College and above	67(16.11)	57(82.53)	10(17.47)
Average monthly Income	<5000	191(41.79)	22(10.86)	169(89.14)
	5000-10000	161(35.23)	48(32)	113 (68)
	>10000	105(22.93)	84(82.47)	21 (17.53)
Median exposure	No	159(34.72)	11(6.8)	148 (93.2)
	Yes	299(65.28)	144(47.29)	155 (52.71)

Household head	Husband	336(73.36)	126(39.22)	210 (60.78)
	Self	122(26.64)	29 (14.89)	93 (85.11)

Table 2. Past and current obstetrics factors related to time to Antenatal care initiation in madawalabu district public Health facilities,2024.

			Time to Antenatal care initiation	
		Frequency (%)	Event N (%)	Censored N (%)
Gravidity	Primigravida	213(46.51)	71(33.17)	142(66.83)
	Multigravida	173(37.77)	65(38.96)	108(61.04)
	Grand multigravida	72(15.72)	19(25.72)	53(74.28)
Parity	Nulliparity	213(46.51)	72(38.81)	141(61.19)
	Multiparity	201(43.88)	69(34.33)	132(65.67)
	grand multipara	44(9.61)	14(31.81)	30(68.19)
Died child	Yes	51(20.82)	7 (14.28)	44 (85.72)
	No	194(79.18)	80(40.10)	114 (59.90)
Abortion history	No	191(77.41)	73(38.91)	118 (61.09)
	Yes	54(22.59)	14 (22.2)	41 (77.78)
Stillbirth history	No	211(86.12)	77 (36.4)	134 (63.6)
	Yes	34(13.88)	10 (30.3)	24(69.7)
Birth interval	< 36 months	109(44.49)	18(16.51)	91(83.49)
	> =36 months	136(55.51)	69(50.73)	67(49.27)
ANC for past pregnancy	No	89(36.33)	12(13.48)	77(86.52)
	Yes	156(63.67)	73(46.79)	83(53.21)
ANC starting time before this pregnancy	< 3 months	69(41.57)	26(37.68)	43(62.32)
	>=3 months	76(45.78)	47(61.84)	29(38.16)
	Don’t remember	11(12.65)	5(45.45)	6(54.55)
Number of contacts	One	5(3.21)	5(100)	0(0)
	Two to three	52(33.33)	22(42.31)	30(57.69)
	Four and more	71(45.51)	40(54.79)	31(43.2)
	Don’t remember	28(17.95)	10(35.71)	18(64.29)
Place of last	Home	61(24.90)	6(9.84)	55(90.16)

birth	Facility	184(75.10)	81(44.02)	103(55.98)
History of c/s	No	180(73.47)	44(24.44)	136(75.56)
	Yes	65(26.53)	44(67.69)	21(32.31)
Planned pregnancy	Yes	376(82.28)	215(57.18)	161(42.82)
	No	82(17.72)	20(24.69)	61(75.31)
Plan include husband	No	100(37.60)	63(63)	37(37)
	Yes	276(62.40)	199(72.10)	77(27.90)
decision on ANC care utilization	Husband	130(28.38)	26(20)	104(80)
	Wife	142(31.00)	30(21.13)	112(78.87)
	Husband and wife	166(36.24)	97(58.43)	69(41.57)
	My mother	20(4.37)	2(10)	18(90)
pregnancy recognition	missed period	167(36.46)	27(16.17)	140(83.83)
	Urine test	291(63.54)	128(43.99)	163(56.01)
counselled to start ANC	No	231(50.44)	26(11.26)	205(88.74)
	Yes	227(49.56)	129(56.83)	98(43.17)
Source of counsel	Husband	20(8.81)	6(30)	18(70)
	HEW	160(70.48)	111(69.38)	49(30.62)
	Mother	30(13.22)	7(23.33)	23(76.67)
	Sister	9(3.96)	2(22.22)	7(77.78)
	Friend	8(3.52)	3(37.5)	5(62.5)
counselling month	<3 months	143(63)	105(84.68)	18(15.32)
	>=3 months	84(37)	24(28.57)	60(71.43)

Table 3. Health Services and Knowledge of ANC Among Pregnant Women in Public Facilities of Madawalabu District, 2024.

Categories		Frequency (%)	Time to Antenatal care initiation	
			Event	Censored
Distance from HF	>= 60 minutes	222(48.470)	70(15.87)	180(84.13)
	< 60 minutes	236(51.53)	166(70.34)	42(17.80)
Has health Insurance	No	226(49.34)	63(27.88)	190(84.07)
	Yes	232(50.66)	173(74.57)	32(13.79)
ANC waiting time	<30 minutes	89(35.18)	75(84.27)	21(23.60)
	>=30 minutes	164(64.82)	67(40.85)	90(54.88)
ANC waiting time is problem	No	86(34.40)	69(80.23)	26(30.23)
	Yes	164(65.60)	72(43.90)	83(50.61)
Scanned for Ultrasound	Yes	120(45.45)	10(87.50)	13(10.83)
	No	144(54.55)	42(29.17)	104(72.22)

Table 4. Comparison of survival times using the Log-Rank test for equality across different covariates among study participants, 2024.

Variables	Categories	Time to ANC initiation		Log rank test (chi^2)	P value
		Event observed	Event expected		
Residence	Rural	33	88.77	90.95	0.0001
	Urban	122	66.23		
Women occupation	House wife	44	95.52	134.04	0.0001
	Merchant	56	42.85		
	Gov't employee	55	16.63		
Women educational status	No formal education	2	45.06	235.22	0.0001
	Primary	36	67.03		
	Secondary	32	17.87		
	College and above	85	25.04		
Median exposure	No	11	61.40	75.96	0.0001
	Yes	144	93.60		
House hold head	Husband	126	111.09	7.79	0.0053

	Wife	29	43.18		
Child loss	Yes	7	19.50	11.44	0.0007
	No	79	66.50		
Had abortion	No	73	66.51	2.97	0.0805
	Yes	14	20.49		
Had stillbirth	No	77	74.27	0.76	0.3840
	Yes	10	12.73		
Birth interval	< 36 months	18	42.61	30.97	0.0001
	>=36months	69	44.39		
ANC for last pregnancy	No	14	34.28	22.13	0.0001
	Yes	71	50.72		
Place of last birth	Facility	80	62.12	20.52	< 0.0001
	Home	6	23.88		
Had c/s	No	44	66.63	36.67	< 0.0001
	Yes	43	20.37		
Means of pregnancy recognition	Normal period	25	62.37	41.62	< 0.0001
	Urine test	129	91.63		
Ultrasound scan	Yes	91	34.81	160.64	< 0.0001
	No	4	60.19		

Table 5: Results of the bivariable and multivariable Cox regression analysis among pastoral pregnant women in Madawalabu district, 2024.

Predictors	Category	CHR (95%CI)	P value	AHR (95%CI)	P value
Residence	Rural	1		1	
	Urban	5.03 (3.42, 7.46)	0.0001	1.96(1.07, 3.59) *	0.030
Occupation	House wife	1		1	
	Merchant	2.97 (1.99,4.42)	0.0001	0.97(0.43, 2.17)	0.94
	Gov't employee	7.7(5.12,11.54)	0.0001	1.31(0.53, 3.25)	0.56
Women education	No formal	1		1	
	Primary	2.28(2.95,5.05)	0.001	1.26(0.09 ,17.49)	0.87
	Secondary	4.58(10.19, 17.93)	0.0001	4.66(0.31,70.70)	0.27

	College and above	8.57(20.27,36.24)	0.0001	1.65(1.21 ,2.25) *	0.002
Husband education	No formal	1		1	
	Primary	3.9(1.91,7.95)	0.0001	2.10(0.49, 8.59)	0.32
	Secondary	10.2(1.91,7.95)	0.0001	2.63(0.57, 12.21)	0.22
	College and above	17.36(8.56,35.18)	0.0001	1.99(0.44, 9.04)	0.37
Monthly income	<5000	1		1	
	5000-10,000	2.95(1.78,4.89)	0.0001	0.85(0.29, 2.54)	0.77
	>10,000	10.77(6.71,17.29)	0.0001	1.15(0.38, 3.46)	0.79
Median exposure	No	1		1	
	Yes	8.69(4.71,16.8)	0.0001	1.16(0.38, 3.54)	0.79
Household head	Husband	1		1	
	Wife	0.58(0.39,0.87)	0.009	0.46(0.26,0.81) *	0.008
Child loss	Yes	1		1	
	No	3.35(1.55,7.26)	0.002	3.07(0.87, 10.76)	0.80
Birth interval	<36 months	1		1	
	>=36 months	3.7(2.20,6.24)	0.0001	1.60(0.69, 3.73)	0.27
ANC for last pregnancy	No	1		1	
	Yes	3.4(1.93,6.09)	0.0001	0.66(0.26,1.640)	0.37
Place of last birth	Home	1		1	
	Facility	5.2(2.27,11.92)	0.0001	0.59(0.12,3.09)	0.54
C/S history	No	1		1	
	Yes	3.34(2.17,5.05)	0.0001	0.58(0.28,1.17)	0.13
Planned pregnancy	Planned	1		1	
	Unplanned	0.25(0.13,0.49)	0.0001	1.09(0.13,8.92)	0.93
Plan include husband	No	1		1	
	Yes	4.3(2.4,7.8)	0.0001	1.14(0.14,8.96)	0.90

pregnancy recognition	Missed period	1		1	
	Urine test	3.6(2.3,5.5)	0.0001	1.16(0.47, 2.88)	0.75
Get counseling	No	1		1	
	Yes	6.8(4.4,10.5)	0.0001	3.17(1.18, 8.54) *	0.022
Get information	No	1		1	
	Yes	7.4(4.5,12.4)	0.0001	1.51(0.54,4.23)	0.43
Distance	>= 60 minutes	1		1	
	<60 minutes	10.6(6.4,17.6)	0.0001	1.36(0 .49,3.76)	0.55
Health insurance	No	1		1	
	Yes	25.1(12.3,51.2)	0.0001	2.5(0.68,9.54)	0.16
ANC waiting time	<=30minutes	1		1	
	>30minutes	0.19(0.12,0.29)	0.0001	0.9(0.34,2.49)	0.88
ANC waiting time is a problem	No	1		1	
	Yes	0.3(0.20,0.45)	0.0001	1.46(0.67,3.18)	0.34
Scanned U/S for last pregnancy	Yes	1		1	
	No	0.03(0.01,0.07)	0.0001	0.12(0.04 ,0.32) *	0.001
Knowledge related to ANC	Poor	1		1	
	Moderate	2.66(1.52,4.67)	0.001	2.24(0.69 ,7.30)	0.18
	Good	10.11(6.18,16.52)	0.0001	1.64(1.14,2.36) *	0.007

Table 6. Global Test of Proportional Hazards assumption for time to Antenatal care initiation and its predictors among pastoral pregnant women in madawalabu district Health facilities,2024.

Variables	Rho	chi2	Df	Prob>chi2
Residence	0.03128	0.1	1	0.7552
Mothers' occupation	-0.05308	0.28	1	0.5964
Women educational status	-0.04923	0.29	1	0.5872
Partner educational level	-0.02022	0.04	1	0.8325
Monthly income	-0.01590	0.03	1	0.8718
Median exposure	0.02250	0.04	1	0.8335
Household head	0.06124	0.27	1	0.6007
Had child loss	0.04895	0.18	1	0.6680
Age of last child	0.07596	0.67	1	0.4147
Had ANC for previous pregnancy	0.05727	0.29	1	0.5881

Birthplace	0.17667	3.44	1	0.0638
Caesarian delivery	0.06973	0.42	1	0.5181
Planned pregnancy	0.00786	0.01	1	0.9426
Plan include husband	0.03383	0.01	1	0.7532
Means of pregnancy recognition	0.00559	0.00	1	0.9632
Counselled	0.05119	0.21	1	0.6437
Informed	-0.00642	0.00	1	0.9515
Distance	-0.08499	0.58	1	0.4570
Health insurance	-0.18997	1.96	1	0.1615
ANC waiting time	0.03792	0.17	1	0.6788
Waiting time is a problem	-0.05015	0.22	1	0.6409
Scanned ultrasound for previous pregnancy	0.05198	0.13	1	0.7206
Knowledge categories	0.23800	7.47	1	0.0063
Global test		**22.00**	**23**	**0.5205**

Table 7. Multicollinearity assessment for covariates in multivariate analysis.

Variable	VIF	1/VIF
Women educational status	3.70	0.270496
Informed	3.02	0.330818
Counselled to initiate ANC	2.89	0.345464
Ultrasound scanned for previous pregnancy	2.44	0.409838
Partner educational level	2.36	0.423800
Plan include husband	2.29	0.437342
Health insurance	2.18	0.459587
Means of pregnancy recognition	2.17	0.461035
ANC waiting time	1.92	0.520952
Monthly income	1.86	0.538788
Mothers	1.80	0.554815
Distance	1.77	0.563533
Waiting	1.77	0.566182
Knowledge categories	1.68	0.596940
Median exposure	1.67	0.600365
ANC for proceeding pregnancy	1.64	0.609680
Birth place	1.55	0.646605

caesarian delivery	1.53	0.652210
Age of last child	1.44	0.693834
Planned pregnancy	1.34	0.746849
Child loss	1.21	0.826254
Household head	1.14	0.875380
Mean VIF	**1.97**	

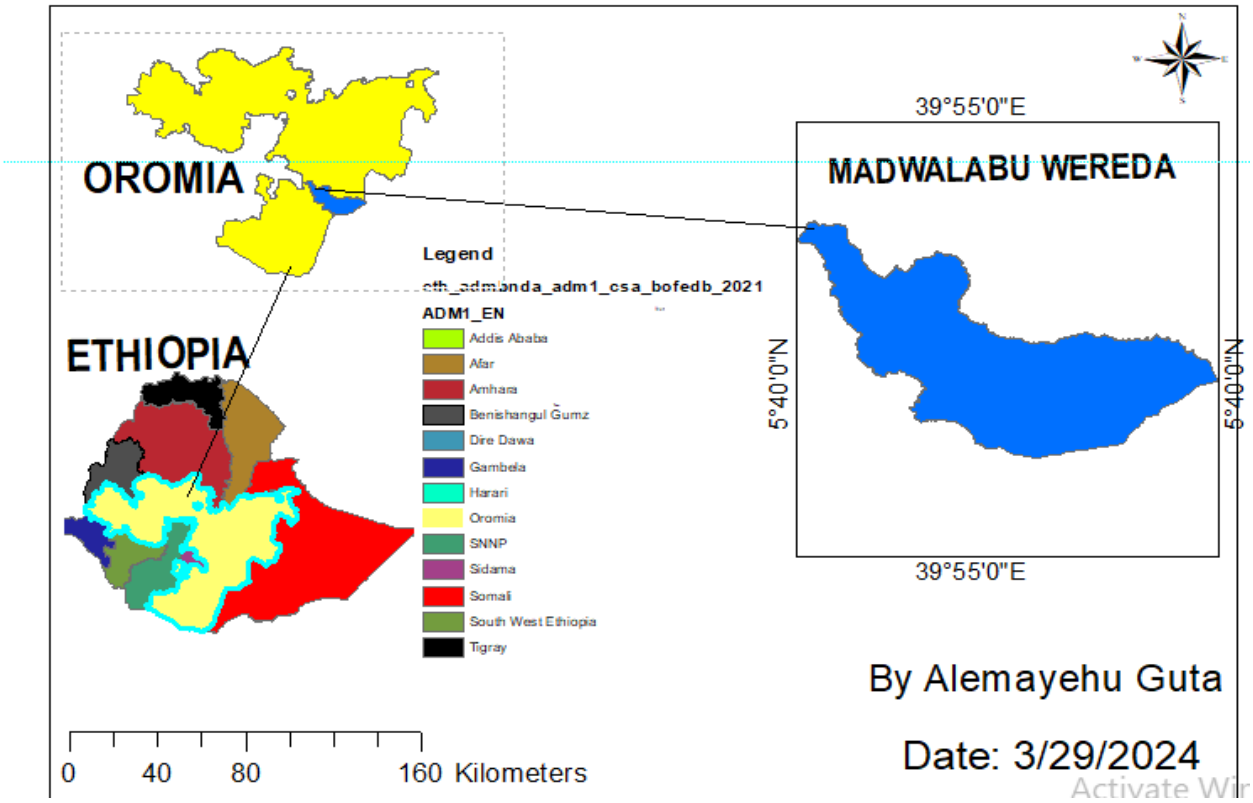


Figure 1. Map of the research area for time to initiation of Antenatal care and its predictors among pastoral pregnant women in Madawalabu district Health facilities public, Oromia, Southeastern Ethiopia, 2024.

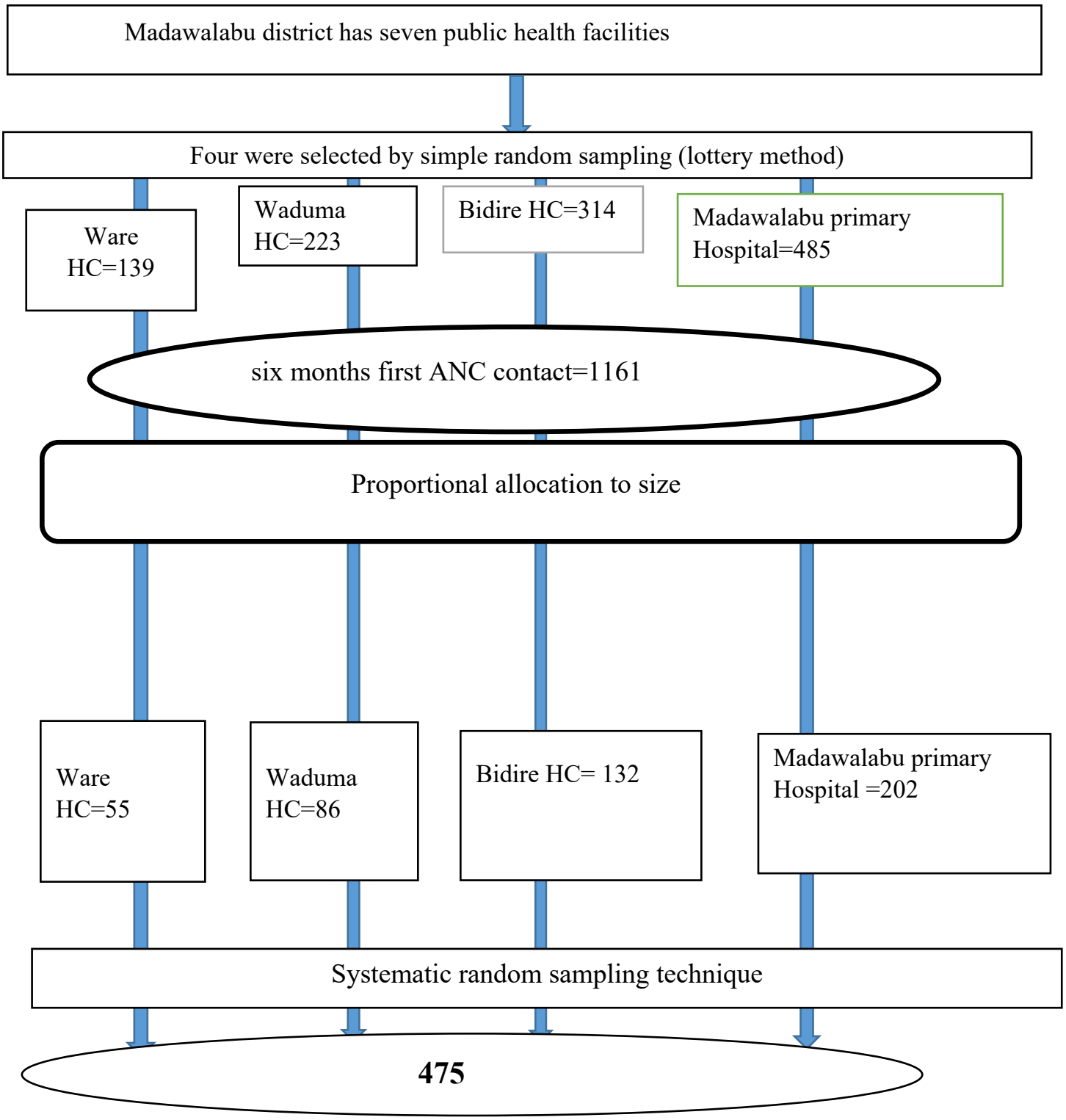


Figure 2: Schematic presentation of sampling procedure for time to initiation of antenatal care and its predictors among pastoral pregnant women in Madawalabu district public Health facilities Oromia, Southeastern Ethiopia, 2024.

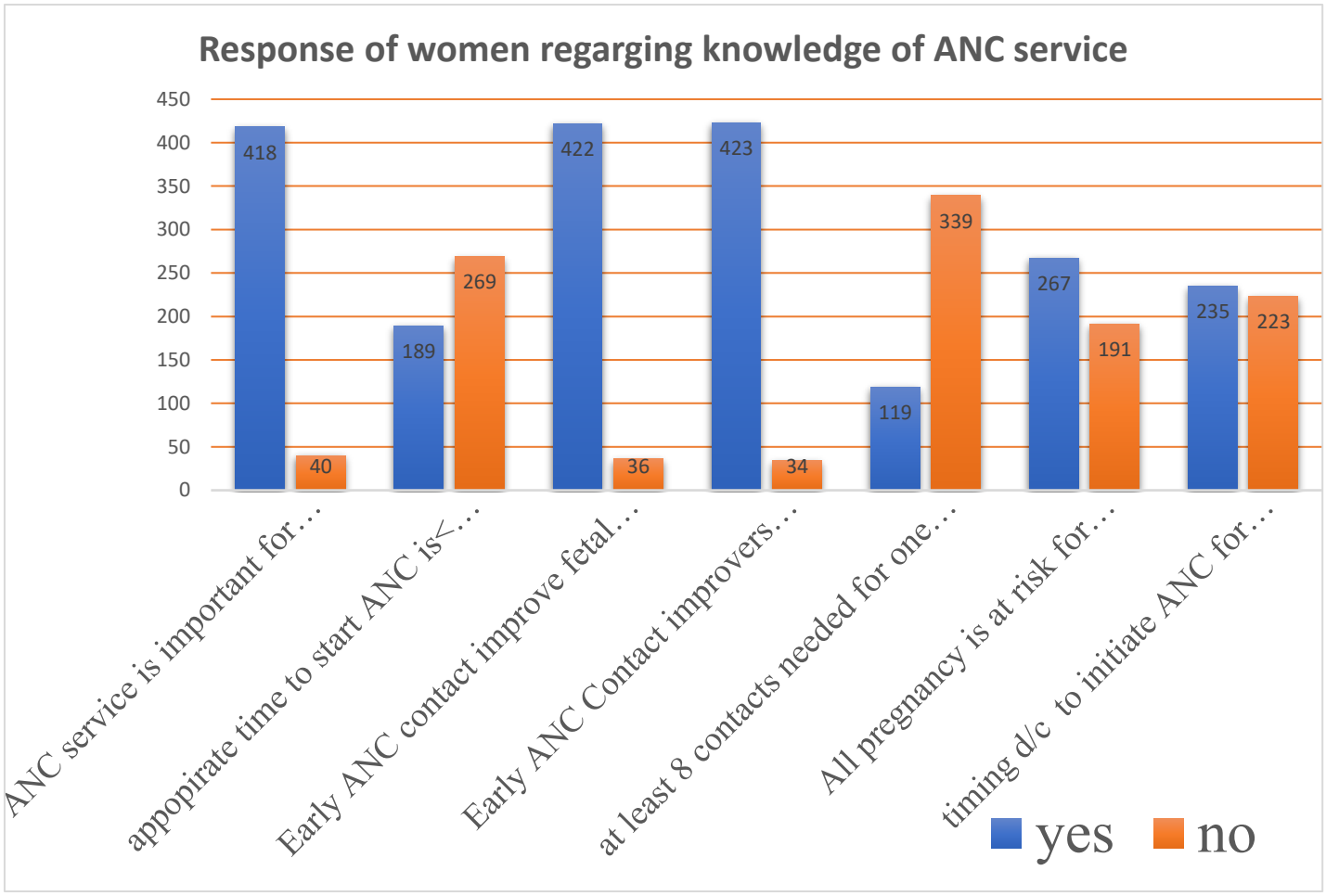


Fig.3. Responses of pregnant women regarding knowledge of antenatal care services in public Health facilities of Madawalabu district, 2024.

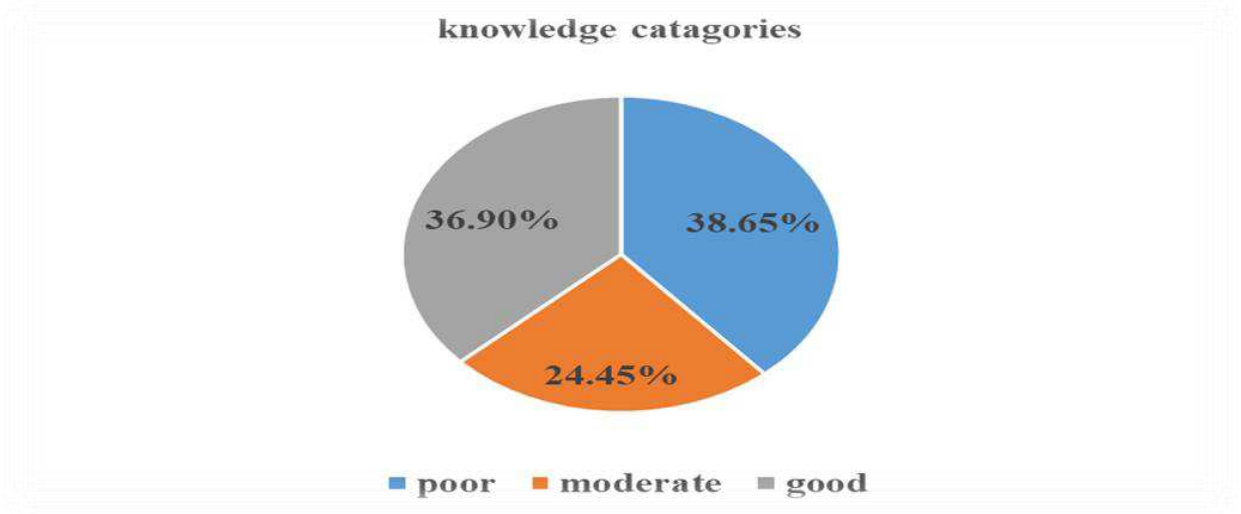


Fig.4. Knowledge Categories of ANC service among Pregnant Women in Public Facilities of Madawalabu District, 2024.

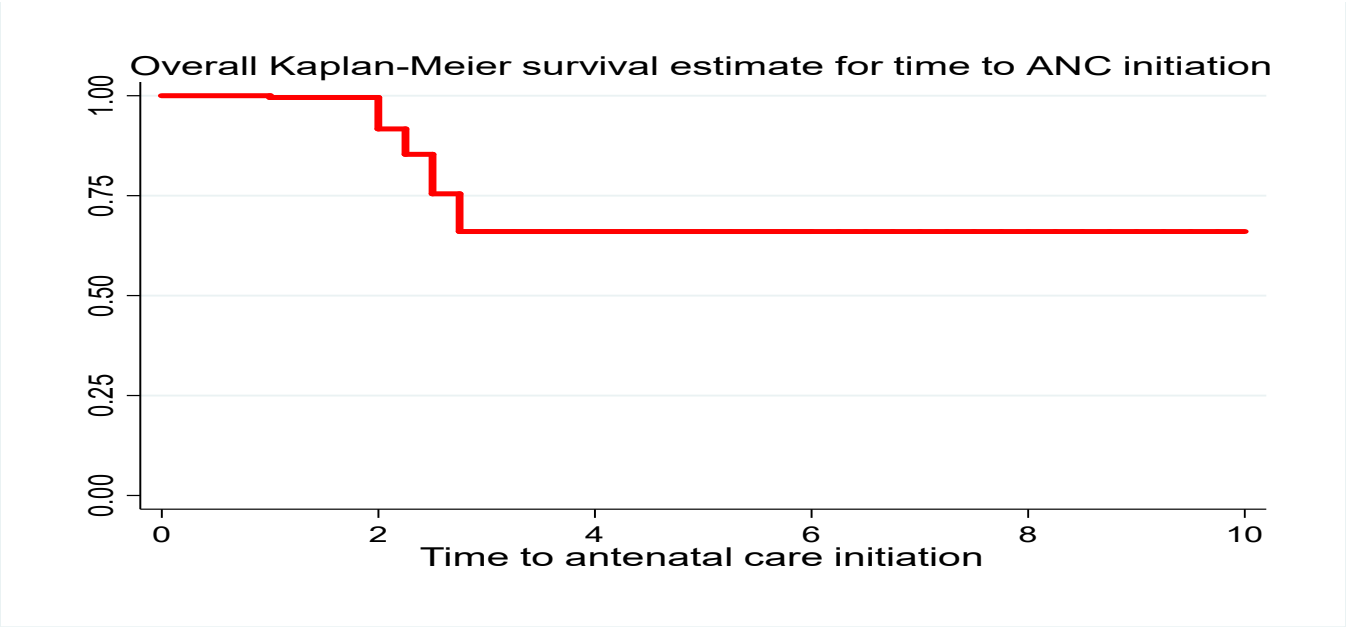
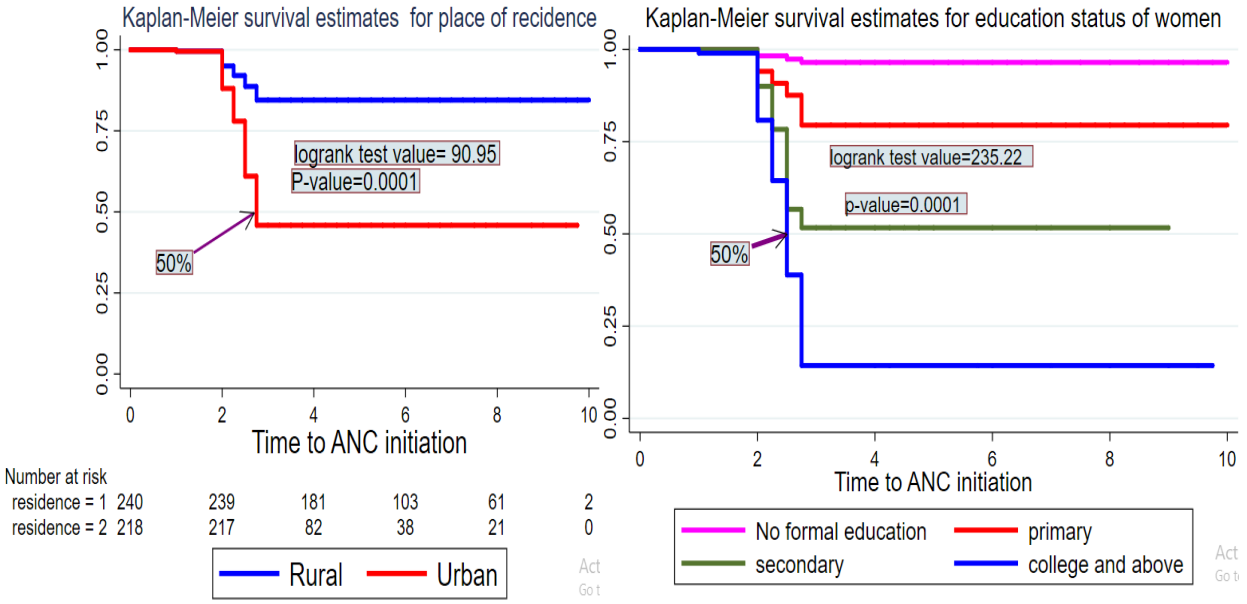


Fig.5. Overall Kaplan-Meier survival estimates of time to Antenatal care initiation and its predictors among pastoral pregnant women in madawalabu district public health facilities,2024.



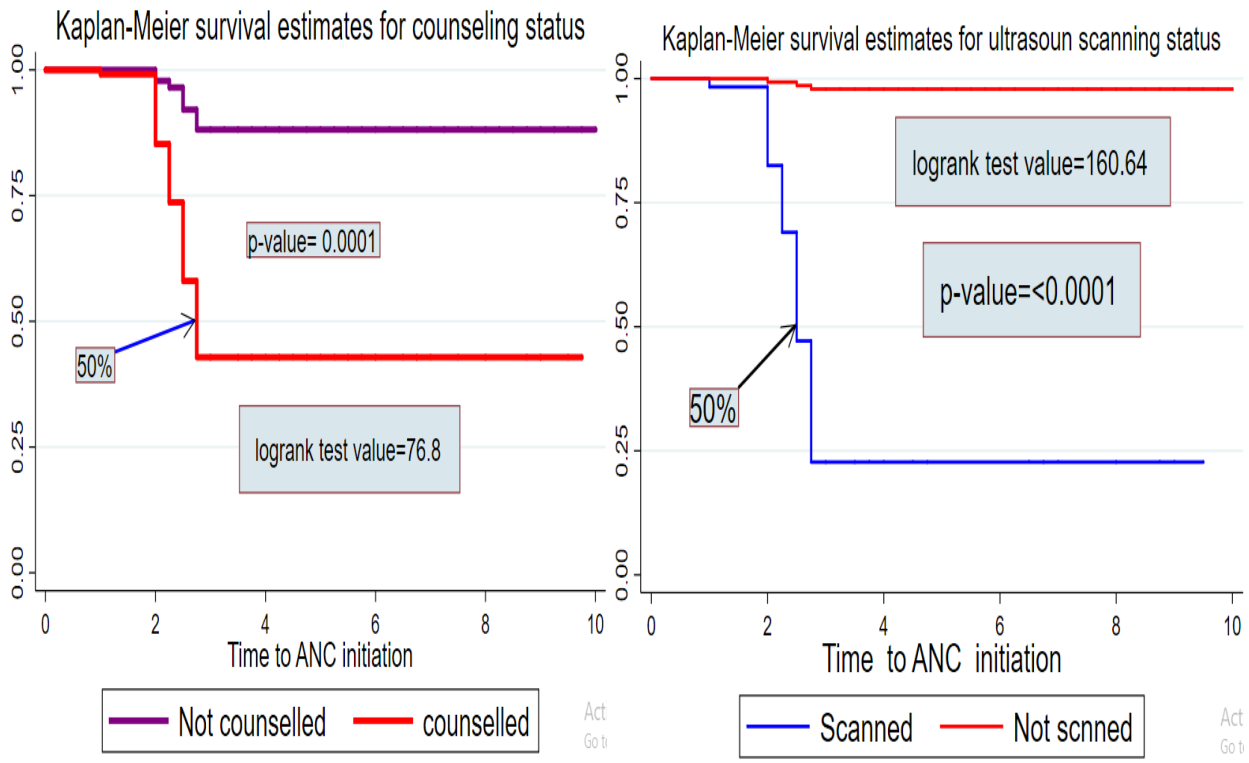


Fig.6. Comparison of survival time for groups of variables of time to antenatal care initiation and its predictors among pastoral pregnant women in madawalabu district public health facilities, 2024.

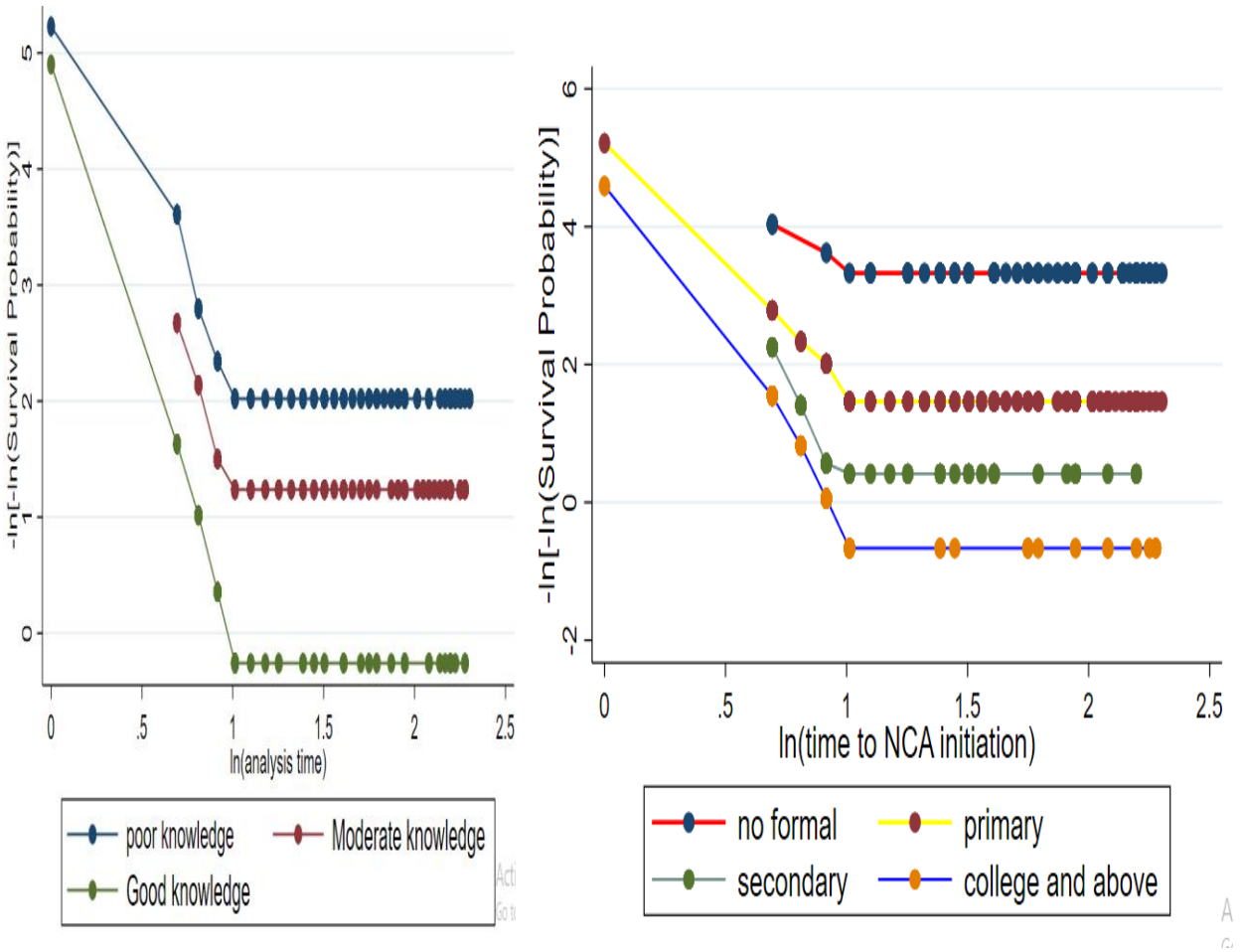


Fig.7. Graphical assumption test for cox regression analysis for time to antenatal care initiation among pastoral pregnant women in madawalabu district public health facilities, 2024.

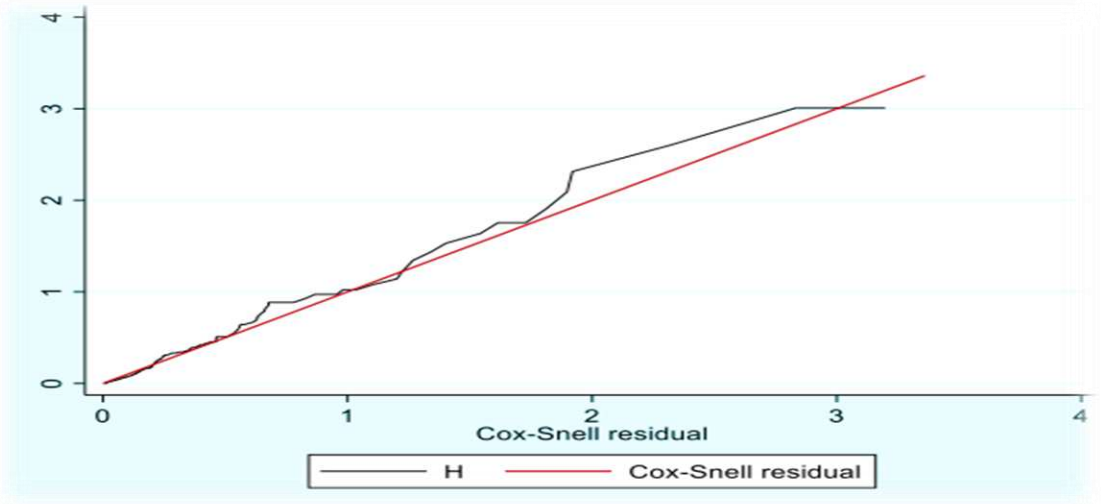


Fig.8. Cox-Snell residual Nelson-Alen cumulative hazard graph on time to Antenatal care initiation and its predictors in Madawalabu District Public Health Facilities, 2024.