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**Delayed ART initiation in “Test and Treat era” and its factors among adults receiving ART at Public health institutions in Northwest Ethiopia: A multicenter cross-sectional study**

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| Short Title:       | Delayed ART initiation in “Test and Treat era” and its associated factors |
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| Keywords:          | Delayed ART initiation, Test and Treat era, Factors, Bahirdar, Northwest Ethiopia |
| Abstract:          | Background: Combined use of antiretroviral therapy (ART) has been the mainstay treatment and prevention option of HIV/AIDS. Hence, WHO has launched a universal test and treat strategy that recommends rapid or within seven initiation of ART to end HIV epidemics by 2030. However, information on timely ART initiation status in Ethiopia are scarce. Method: Multicenter cross-sectional study was conducted on 400 HIV-positive adults receiving ART at public health institution of Bahirdar city. Data were extracted from patients’ chart using a checklist adapted from ART intake and follow-up forms. The extracted data were entered into Epidata and exported to SPSS version 26 for statistical analysis. Both bivariable and multivariable logistic regression was executed and variables with p-values < 0.05 in the multivariable model were considered significant predictors of delayed ART initiation. Results: The burden of delayed ART initiation was 156 (39%) [95% CI, 34% - 44%]. Being male (AOR 1.99, 95% CI: 1.26 - 3.16), opportunistic infections (AOR 2.5, 95% CI: 1.38 4.58), chronic problems (AOR 3.7, 95% CI: 1.67 8.3), substance abuse (AOR 3.79, 95% CI: 1.9 7.4), ambulatory functional status (AOR 5.38, 95% CI: 1.4 - 9.6) and didn’t know other HIV positive family member (AOR 1.85, 95% CI: 1.2 - 2.9) increases the odds of delayed ART initiation. Conclusion and Recommendation: The magnitude of delayed ART initiation is found to be high. Male sex, presence of OIs and chronic problems, substance abuse, ambulatory functional status and not knowing other HIV-positive family members were identified as significant factors of late ART initiation. Special emphasis shall be considered on those with no enough social support and suffered with other comorbidities. |
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Delayed ART initiation in “Test and Treat era” and its associated factors among adults receiving ART at Public health institution in Northwest Ethiopia: A multicenter cross-sectional study

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Abstract

**Background:** Antiretroviral Therapy (ART) has shown promising effects on the reduction of new HIV infection as well as HIV-related morbidity and mortality. Indeed, since 2015 G.C, WHO launched a universal test and treat strategy so as to boost its effect on ending HIV epidemics by 2030. However, information on timely ART initiation status in Ethiopia are scarce.

**Method**- Multicenter cross-sectional study was conducted on 400 HIV-positive adults receiving ART at public health institution of Bahirdar city. Data were extracted from patients’ chart using a checklist adapted from ART intake and follow-up forms. The extracted data were entered into Epidata and exported to SPSS version 26 for statistical analysis. Both bivariable and multivariable logistic regression was executed and variables with p-values < 0.05 in the multivariable model were considered significant predictors of delayed ART initiation.

**Results**- The burden of delayed ART initiation was 156 (39%) [95% CI, 34% - 44%). Being male (AOR 1.99, 95% 1.26 -3.16), opportunistic infections (AOR 2.5, 95%CI 1.38 4.58), chronic problems (AOR 3.7, 95%CI: 1.67 8.3), substance abuse (AOR 3.79, 95%CI: 1.9 7.4), ambulatory functional status (AOR 5.38, 95%CI 1.4- 9.6) and didn’t know other HIV positive family member (AOR 1.85, 95%CI: 1.2-2.9) increases the odds of delayed ART initiation.

**Conclusion and Recommendation**- The magnitude of delayed ART initiation is found to be high. Male sex, presence of OIs and chronic problems, substance abuse, ambulatory functional status and not knowing other HIV-positive family members were identified as significant factors of late ART initiation. Special emphasis shall be considered on those with no enough social support and suffered with other comorbidities.

Keywords – Delayed ART initiation, Test and Treat era, Factors, Bahirdar, Northwest Ethiopia
1. Introduction

By the end of 2020, UNAIDS reported that nearly 37.7 million individuals were living with HIV/AIDS worldwide; of which 20.6 million reside in Eastern and South Africa regions (1). To end HIV epidemics, the combined use of antiretroviral therapy (ART) has been the mainstay treatment and prevention option since the late 1980. ART has also provided promising effects on the reduction of new HIV infection as well as HIV-related morbidity and mortality. According to the UNAIDS 2020 report, ART has contributed to 30 and 42% reduction in new HIV infection and HIV-related mortality respectively since 2010(1).

The WHO has launched the Universal Test and Treat (UTT) strategy of HIV/AIDS since 2015 for the success of UNAIDS 2014 three 95 ambitious goals(2). Universal test and treat strategy was define as the initiation of ART within seven days of confirmation of HIV irrespective of the WHO clinical staging as well as CD4+ levels of the patient (2, 3). This rapid ART initiation has been found to have numerous positive effects on reducing HIV-related morbidity and mortality. The main important effects were increasing access to ART, ensuring maximal and durable viral load suppression, restoring and preserving immune function, improve quality of life, and preventing further transmission of HIV/AIDS (4–8). Despite such remarkable benefits, delayed ART initiation has continued to a major challenge for the success of ending HIV epidemics by 2030 particularly in resource limited settings (9). For instance, In Taiwan, only 68.3 % of HIV positive individuals were initiated to ART rapidly by 2016 (4). Similarly in South Africa and Zimbabwe, only 54 % and 65% of HIV positive individuals were initiated in to ART on the same day of HIV confirmation respectively(10, 11). Though there are a limited evidences in Ethiopia, finding from a study conducted at Nekemte hospital, Western Ethiopia revealed that nearly 34% of HIV positive patients were enrolled to ART beyond seven days of diagnosis(12).
Correspondingly, in Northern Ethiopia only 41.9% of adults were initiated to ART on same day of ART diagnosis (13).

Delayed ART initiation is associated with low immunologic response, enhancing treatment failure, increases patient hospitalization, increase burden of opportunistic infections, increase costs from chronic problems, increases morbidity and mortality of patients (13-16). Peoples living with HIV/AIDS who didn’t know other ART users, had TB/HIV co infection, visit traditional healers, had CD4 count > 351 cells/ mm³, had normal BMI status were more likely to enrolled into ART lately than their respective counterparts (12, 17, 18). Furthermore, residence, educational status, marital status, age, alcohol abuse, distance from ART center, perceived susceptibility and severity towards HIV/AIDS, and perceived home-based care status significantly affects the time to ART initiation (19-22). To overcome this problem, solutions such as continuous professional development on HIV/AIDS management protocol, continuous updating of management guideline, scaling up ART centers, providing client-centered follow up system, formulating fixed dose combination ART drugs and providing continuous health education and promotion activities were proposed and implemented both at national level and worldwide (23, 24).

Despite such efforts a significant portions of individuals didn’t has access to ART and time of ART initiation was not adequately known for those who already enrolled into ART. Hence this study will fill the gap by estimating the magnitude of delayed ART initiation with its predictor variables.

2. Methods and Materials

Study Design and Period

An institution-based cross-sectional study was conducted among 400 individuals who has enrolled into ART from November 2016 to October 2020 at public health institutions of Bahirdar City.
city is the area of the earliest ART service center in Amhara regional state. It is located at 565 km Northwest of Addis Ababa, the capital city of Ethiopia. Currently, the city has around 11 (two hospitals and nine health center) functional ART centers. According to the report of the Amhara regional health bureau, the city bears the highest burdens of HIV/AIDS patients load in the region by which nearly 14024 individuals were ever enrolled at those institutions for ART care and services. From the above figure, a total of 2822 HIV-positive patients were newly enrolled in to ART after the implementation of the treat-all strategy.

**Study Subjects**

The source population for this study was all adults receiving ART after test and treat era at public health institutions in Bahirdar city. The study population was all adults newly initiated into ART from November 2016 to December 2017 at public health institutions in Bahirdar city. PLHIV who had TB/HIV coinfection at presentation, Cryptococcus meningitis infection, and individuals of with incomplete record of HIV diagnosis and initiation date were excluded from the study.

**Sample size determination and Sampling technique**

The minimum sample size required to conduct this study was calculated by double population proportion formula through EPINFO version 7.2. 3.1 software. Parameters such as power 80%, 95% confidence level, 25.8% proportion of outcome in unexposed group and Odds ratio of 1.87 were considered and final a total of 400 were estimated to conduct this study. Study participants were selected by computer generated simple random sampling technique after combining unique ART number of eligible patients from all ART centers in the city.

**Study Variables**

The main response /dependent variable for this study is the occurrence of delayed ART initiation. Whereas variables like age, sex, level of education, marital status, occupation, residence,
catchment area, have HIV positive family member, having cell phone status, baseline CD4 count, baseline WHO clinical stage, baseline functional status, baseline nutritional status, presence of OIs except Tuberculosis (TB) and Cryptococcus meningitis, baseline Substance abuse status, disclosure status were categorized as independent predictor variables.

**Operational Definitions**

Time to ART initiation is the time interval in a day from the confirmation of HIV status till the patient is enrolled into ART. Rapid ART initiation is defined as the initiation of ART within seven days of confirmation of diagnosis irrespective of their WHO clinical staging as well as CD4+ cell counts (23, 25). The functional status of the patient is categorized as “working” if daily activities of Peoples living with HIV/AIDS was not altered due to illness, “ambulatory” if the patient was not fully working but was able to do minor tasks at home, and “bedridden” when the patient remained in bed most of the time (23). BMI status was calculated by dividing body weight by height squared. It was classified as: well-nourished (BMI: 18.5 - 24.99 Kg/m²), undernourished (BMI < 18.5 Kg/m²), and overweight (BMI ≥ 25 Kg/m²). Disclosure is recorded yes when the status of the individual is disclosed to at least one individual (23). Individuals will be categorized as substance abuse when the patient scores two or more on Cut down, Annoyed, Guilty, and Eye-opener (CAGE) substance abuse screening tool (26).

**Data Collection Instrument and Procedures**

The data abstraction tool was adapted from the Federal Ministry of Health (FMOH) ART follow-up, the patient intake and monitoring formats. The data was collected by three BSc Nurse Professionals with the close supervision by one master of public health expert. To assure data quality, one day training was given for both data collectors and supervisors about the purpose of the study, the way to extract relevant data, and ensure the confidentiality issue of the patient.
information. In addition the consistency of the checklist against the patient chart was verified by taking 10 charts and necessary modification was done accordingly.

Data processing and analysis procedures

The data was initially coded, entered into Epi data version 4.6.0.0 and simultaneously exported to SPSS version 26 software for further statistical analysis. Median, Interquartile Range (IQR) for continuous variables and proportions for categorical variables were respectively used to summarize the data. Moreover, tables and graphs were also used to present data. Both bi-variable and multivariable logistic regression were fitted to identify the predictors of delayed ART initiation and those variables with p-value <0.05 in the multivariable analysis were considered as significant predictors of delayed ART initiation. Backward elimination technique was used to select variables on multivariable logistic regression model. After fitting the final model, “Hosmer and Lomeshow” goodness of fit test was used to assess the over model goodness of the regression. In addition, the discriminative power of the study was affirmed by receiver operating characteristic curve (ROC curve) and area under curve score of greater than 70 was considered as the model had good discrimination probability.

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board (IRB) of Bahirdar University, College of Medicine and Health Science with a protocol number of 058/2021. Then, a permission letter was obtained from the directors and ART clinic focal person of those health institutions sequentially to obtain consent to use patients' charts as a source of information. Besides, patient identifiers (patient’s MRN number) were replaced by new identification numbers during data entry period.
3. Result

Sociodemographic characteristics

A total of 400 (100%) HIV-positive adults who were enrolled in ART following Test and Treat strategy were included for final analysis. Of these, more than half of them were females (57.3%), married (51.5%), and had positive family members (59.0%). The median age of the study participants was 32 years, with an interquartile range (IQR 27-40 =13) of years. Regarding to their residence, around 229 (57.3%) of individuals reside beyond their catchment area (Table 1).

Table 1. Clinical and Behavioral characteristics of HIV positive adults receiving ART at Public health institutions in Bahirdar city, Northwest Ethiopia, From November 2016 to December 2020

| Variables          | Category      | ART Initiation |                  |                  |                |                  |                  |
|--------------------|---------------|----------------|------------------|------------------|----------------|------------------|------------------|
|                    |               | Lately initiated | Early initiated | Total frequency | %              |                  |                  |
| Sex                | Male          | 83             | 88               | 171              | 42.8           |                  |                  |
|                    | Female        | 73             | 156              | 229              | 57.3           |                  |                  |
| Age category       | Age 15-24     | 22             | 39               | 61               | 15.2           |                  |                  |
|                    | Age 25-34     | 62             | 114              | 176              | 44.0           |                  |                  |
|                    | Age 35-45     | 57             | 71               | 128              | 32.0           |                  |                  |
|                    | Age >45       | 15             | 20               | 35               | 8.8            |                  |                  |
| Marital status     | Married       | 78             | 128              | 206              | 51.5           |                  |                  |
|                    | Not Married   | 78             | 116              | 194              | 48.5           |                  |                  |
| Educational status | No formal education | 47         | 70               | 117              | 29.3           |                  |                  |
|                    | Primary education | 42        | 57               | 99               | 24.7           |                  |                  |
|                    | Secondary     | 37             | 69               | 106              | 26.5           |                  |                  |
|                    | Tertiary and above | 30       | 48               | 78               | 19.5           |                  |                  |
| Occupation         | Daily-laborer | 24             | 58               | 82               | 20.5           |                  |                  |
|                    | Farmer        | 14             | 10               | 24               | 6.0            |                  |                  |
|                    | Merchant      | 26             | 33               | 59               | 14.8           |                  |                  |
|                    | House-wife    | 26             | 41               | 67               | 16.8           |                  |                  |
|                    | Employed      | 44             | 75               | 119              | 29.8           |                  |                  |
|                    | Student       | 11             | 12               | 23               | 5.8            |                  |                  |
|                    | Others        | 11             | 15               | 26               | 6.5            |                  |                  |
| Had positive family member | Yes    | 48             | 116              | 164              | 41.0           |                  |                  |
|                    | No            | 108            | 128              | 236              | 59.0           |                  |                  |
Clinical, Treatment-related and Behavioral Characteristics

The median CD4 and BMI status of the study participants during their enrollment to ART was 316 cell/mm³ with an interquartile range (IQR 502-316 cell/mm³) and 20.42 with IQR (22.67-18.59) respectively. Besides, nearly 13% of individuals had substance abuse to at least one of the common drugs including chat, cigarette and alcohol. About one fourth (26%) of the study participants had at least one OIs. Indeed, significant number of individuals had at least one additional chronic problem that cad add additional burden on their management or overall quality of life (Table 2).

Table 2. Clinical and Behavioral characteristics of HIV positive adults receiving ART at Public health institutions in Bahirdar city, Northwest Ethiopia, From November 2016 to December 2020

| Variables (N=400) | Category | ART Initiation |
|-------------------|----------|----------------|
| Baseline BMI Status | Under weight | Lately initiated 37 | Early initiated 57 | Total frequency 94 | % 23.5 |
| | Normal weight | Lately initiated 109 | Early initiated 161 | Total frequency 270 | % 67.5 |
| | Over weight | Lately initiated 10 | Early initiated 26 | Total frequency 36 | % 9.0 |
| Baseline CD4 level | greater than 500 | Lately initiated 59 | Early initiated 74 | Total frequency 133 | % 33.3 |
| | From 200-499 | Lately initiated 54 | Early initiated 95 | Total frequency 149 | % 37.3 |
| | < 200 | Lately initiated 43 | Early initiated 75 | Total frequency 118 | % 29.5 |
| Baseline WHO staging | WHO stage I&II | Lately initiated 113 | Early initiated 195 | Total frequency 308 | % 77.0 |
| | WHO stage III&IV | Lately initiated 43 | Early initiated 49 | Total frequency 92 | % 23.0 |
| functional status | Working | Lately initiated 137 | Early initiated 180 | Total frequency 317 | % 79.3 |
| | Ambulatory | Lately initiated 14 | Early initiated 52 | Total frequency 66 | % 16.5 |
| | Bedridden | Lately initiated 5 | Early initiated 12 | Total frequency 17 | % 4.3 |
| History of OIs | Yes | Lately initiated 54 | Early initiated 50 | Total frequency 104 | % 26.0 |
| | No | Lately initiated 190 | Early initiated 106 | Total frequency 296 | % 74.0 |
| Presence of Chronic Problems | Yes | Lately initiated 23 | Early initiated 11 | Total frequency 34 | % 8.5 |
| | NO | Lately initiated 133 | Early initiated 233 | Total frequency 366 | % 91.5 |
### Prevalence of late ART initiation

A total of 156 (39%, 95% CI: 34%- 44 %) HIV-positive adults were categorized as having delayed ART initiation (Fig 1). However, ART initiation time was greatly varied among different individuals based on their socio-demographic, clinical and treatment-related conditions of the patient.

#### Figure 1. Delayed ART initiation status of HIV-positive adults receiving ART at public health institutions in Bahirdar city, Northwest Ethiopia, 2021

### Predictors of loss to follow up

During bivariable logistic regression analysis, nine variables which had p-value < 0.25 were recruited for multivariable logistic regression analysis. In the final model, the following six variables namely sex, HIV positive family member, substance abuse, chronic disease, OIs and functional status of the patients were found to be significant predictors of delayed ART initiation at 5% of the level of significance. Accordingly, the odds of delayed ART initiation is nearly two times in males than females (AOR 1.78:- 95% CI 1.13 -2.8). HIV positive individuals who didn’t knew at least one HIV positive family member had nearly two or more odds of delayed ART initiation than individuals who knew at least one family member. The odds of delayed ART initiation among individuals with at least one chronic problem is almost 3.7 times (95% CI: 1.67-8.3) than individuals with no chronic problem. Substance abused HIV positive individuals were 3.79 or more times at risk to be initiated early on ART than their counterparts (3.79, 95%CI 1.9-7.4). The odds of late ART initiation among ambulatory patients is nearly 5 times (5.38, 95%CI 1.4 - 9.6) than bedridden HIV positive patients (Table 3).
Table 3. Bivariable and multivariable logistic regression analysis of Delayed ART initiation among adult on ART at Public health institutions in Bahirdar city, Northwest Ethiopia, from November 2016 to December 2020

| Variable          | Category                | Outcome status       | COR [95% CI]       | AOR [95%CI]       | p-value |
|-------------------|-------------------------|----------------------|--------------------|-------------------|---------|
|                   |                         | Late initiated       | Early initiated    |                   |         |
| Sex               | Male                    | 83                   | 88                 | 2.02 (1.34 3.03)* | 1.99(1.26 3.16)** | 0.01    |
|                   | Female                  | 73                   | 156                | 1                 |         |
| Age category      | Age 15-24               | 21                   | 38                 | 0.39 (0.25 1.71)  |         |
|                   | Age 25-34               | 63                   | 115                | 0.65 (0.27 1.53)  |         |
|                   | Age 35-45               | 61                   | 78                 | 0.92 (0.38 2.2)   |         |
|                   | Age >45                 | 11                   | 13                 | 1                 |         |
| Educational status| no formal education     | 47                   | 70                 | 0.81(0.56 1.93)   |         |
|                   | Primary education       | 42                   | 57                 | 0.59(0.64 2.16)   |         |
|                   | Secondary               | 37                   | 69                 | 0.62(0.47 1.57)   |         |
|                   | Tertiary and above      | 30                   | 48                 | 1                 |         |
| Occupation        | Daily-laborer           | 24                   | 58                 | 1                 |         |
|                   | Farmer                  | 14                   | 10                 | 3.38(1.32 8.67)*  |         |
|                   | Merchant                | 26                   | 33                 | 1.9 (0.95 3.84)   |         |
|                   | House-wife              | 26                   | 41                 | 1.53 (0.77 3.03)  |         |
|                   | Employed                | 44                   | 75                 | 1.42(0.78 2.59)   |         |
|                   | Student                 | 11                   | 12                 | 2.21(0.86 5.70)   |         |
|                   | Others                  | 11                   | 15                 | 1.77(0.71 4.41)   |         |
| Marital status    | Married                 | 78                   | 128                | 1                 |         |
|                   | Not Married             | 78                   | 116                | 0.63 (0.73 1.649) |         |
| Reside on         | Yes                     | 148                  | 81                 | 1                 |         |
| Catchment area    | No                      | 96                   | 75                 | 1.42 (0.47 1.05)  |         |
| HIV-positive family member | Yes | 48   | 116 | 1 | 1 |
|                   | No                      | 108                  | 128                | 2.04 (1.33 3.11)* | 1.85(1.2 2.90)** | 0.01 |
| Having            | Yes                     | 214                  | 144                | 1                 |         |
| Cell_phone        | No                      | 30                   | 12                 | 0.59 (0.29 1.12)  | 0.5 (0.2 1.11) | 0.09 |
| CD4 category      | Greater than 500        | 59                   | 74                 | 1.39 (0.83 2.31)  |         |
|                   | From 200-499            | 54                   | 95                 | 0.99 (0.6 1.64)   |         |
WHO clinical staging

| Stage          | < 200 | 43  | 75  | 1   | 1   |
|----------------|-------|-----|-----|-----|-----|
| Stage I and II | 115   | 195 |     |     |     |
| Stage III and IV | 41    | 49  |     |     |     |

Functional status

| Status        | Working | 136 | 198 | 1.82 (0.63 5.3) | 1   |
|---------------|---------|-----|-----|-----------------|-----|
| Ambulatory    | 14      | 41  |     | 1.82 (0.46 7.12) | 5.38 (1.4 - 9.6)** | 0.01 |
| Bedridden     | 6       | 5   |     |                 | 0.95 (0.2 - 3.67) | 0.94 |

History of OIs

| Yes | 54  | 50  | 1.66 (1.05 2.6)** | 2.5 (1.38 4.58)** | 0.03 |
| No  | 106 | 190 |     |                 |     |

History of chronic diseases

| Yes | 23  | 11  | 3.67 (1.73 7.75) * | 3.7 (1.67 8.3)** | 0.01 |
| No  | 133 | 233 |     |                 |     |

Substance Abuse

| Yes | 19  | 35  | 3.42 (1.88 6.24) * | 3.79 (1.9 7.4)** | 0.01 |
| No  | 225 | 121 |     |                 |     |

1-Reference category, * statistically significant at bi-variable with 5% level of significance, ** statistically significant at multivariable with 5% level of significance, CI- confidence interval,

N.B- Since we used backward likelihood ratio to select candidate variables of delayed ART initiation, we didn’t display the AOR value for variables with P-value of greater than 0.1

Hosmer and Lomeshow goodness of test for multi logistic regression revealed that the model constituting such variables is good to predict the outcome variable i.e delayed ART initiation (P-value =0.639). Indeed the discrimination power of the model was checked by receiver operating curve and the area under the curve value (AOC value = 0.744%) illustrated that the model is excellent to discriminate individuals with delayed ART initiation with their counterparts (Fig 2).

Figure 2. ROC curve graph showing model discrimination power among adults receiving ART following Test and Treat strategy at FHCSH, Northwest Ethiopia, 2021
4. Discussion

There is a dearth of studies that address the time of ART initiation following the implementation of the Test and Treat strategy in Ethiopia. This study has found that about 154 (39% 95%CI: 34-44%) HIV-positive adults were initiated into the ART beyond seven days. This finding is in line with recent studies conducted in Nekemte, Western Ethiopia (12), Ekurhuleni district in South Africa (27), and Zimbabwe (28). On the other hand, this finding is slightly lower than a study conducted in Taiwan(4) which might be due to a difference in socioeconomic and educational status between the two countries.

In the current study male HIV-positive individuals has higher odds of being delayed for ART initiation than their counterparts. This finding is congruent with previous studies conducted at Nekemte(12), and South Africa(10). The possible elucidation for this might be the fact that women’s decision to immediately seek ART will be highly influenced by physician’s counseling than males. Furthermore, if the women were found to be HIV positive during pregnancy, lactating, labor and delivery, she will be highly reinforced to begin ART at the spot or as early as possible.

Furthermore, there is a claim that global and national health policy prioritizing maternal and child health services has result in unequal access to health services, including ART services.

When compared to patients without documented baseline OIs, HIV-positive people with OIs had a two-fold higher odds of delaying ART initiation time. This finding is parallel with prior researches studies conducted at South wollo zone and Nekemte hospital in Ethiopia (12, 29). The main justification for the above finding might be because of concerns about potential drug interactions, poor adherence as a result of pill burden, and immune reconstitution inflammatory syndrome (IRIS), not only the patient but also the health care practitioner may decide to extend ART initiation time. Nevertheless, latest evidence and guidelines recommends for the immediate initiation of ART except for patients with TB/ HIV coinfection and Cryptococcus meningitis.
The risk of delayed ART initiation is nearly four times among HIV-positive individuals with chronic problems than their counterparts. This finding is consistent with previous systematic review and meta-analysis studies conducted before the current test and treat era in Ethiopia\(^{(19)}\). The possible justification for this might be also due to the fear of pill burden, drug-drug interactions, toxicities, and interrupting drugs while treating both chronic problems simultaneously. It implies that continuous professional development through expanding online training, short term and long-term capacity building sessions need to strengthen. Moreover, early ART initiation has a paramount role in the prevention of the incidence of chronic problems in HIV-positive patients.

The odds of delayed ART initiation among individuals with no any HIV-positive family member is higher than individuals with an HIV-positive family member. The possible elucidation for such association might be due to the fact that HIV positive individuals who did know other ART user may got strong reinforcement, and social support than being discriminated or stigmatized when compared with their counterparts. Social support from family or family encourages HIV positive patients to early enrolled on ART as well as retain on it for the rest of their life\(^{(30)}\).

HIV positive individuals who are abused for at least one of the common substances (chat, alcohol and cigarette) had higher odds of being late on ART initiation. The possible explanation for this finding might be due to the fact that substance abuse has an overwhelmed effect on each aspects of HIV/AIDS. Substance abusers, for example, will cause cognitive impairment, which will further hamper their decision-making abilities and rigorous adherence to their ART therapy. This means that HIV positive substance abusers will face a slew of issues, including an increased risk of opportunistic infections, accelerated disease progression, and early mortality from OIs, as well
as the illness itself. The finding is consistent with literature conducted in previous era in South Wollo, and Myanmar (29, 31)

The time it takes for HIV positive people to start taking antiretroviral therapy (ART) has a substantial association with their baseline functional status. This is congruent with studies done in Gondar and South Africa (10, 22). Patients who were ambulatory, for example, had a higher chance of being delayed in receiving ART when compared with working individuals. It could be explained by the fact that HIV positive individuals with working functional status believe they are healthy enough, and that initiating antiretroviral therapy (ART) while they are relatively healthy may not be beneficial.

5. Conclusion and recommendation

In this test-and-treat era, the magnitude of delayed ART initiation is significantly high. Males, in particular, had a high rate of delayed ART initiation compared to their counter parts. Moreover, presence of OIs and chronic problems, substance abuse, ambulatory functional status and not knowing other HIV-positive family members were identified as significant predictors of late ART initiation. This study highlighted the importance of advocating intensive counseling and education to those high risk groups in order to achieve UNAIDS/WHO targets to end HIV epidemic by 2030. Further research shall be undertaken explore the effect of other socio-economical, behavioral, institutional and contextual factors of delayed ART initiation.
Abbreviations

AOR – Adjusted Odds Ratio, BMI - Body Mass Index, CD4-Cluster Differentiation cells, CI- confidence Interval, OIs - Opportunistic Infections , PLHIV - Peoples Living with Human Immune Virus, ROC- receiver operating curve, SSA - Sub-Saharan African country, TB – Tuberculosis, UNAIDS- Joint United Nations Program on HIV/AIDS , UTT- Universal Test and Treat strategy, WHO- World Health Organization.

Declarations

Consent for publication
Not applicable

Availability of data and material
All relevant data’s for this study presented within the manuscript.

Competing interests
All authors have declared that they have no conflicting interests.

Authors’ contributions
BBT: Synthesizing research question, formulate objective the study , design data collection, analysis, interpretation, conclusion preparing initial manuscript draft, design of study, data collection, analysis, interpretation, conclusion, preparing initial manuscript draft

GK, MU, ATA, ABN, AT, GK, TD, NST, NM, AN, DT, MY, EG, AK- Actively participated in
data collection, analysis, interpretation, and conclusion as well as recommendation of the study.
Indeed, they actively participate in writing up manuscript. All authors had thoroughly read and approved the manuscript.
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Figure 1. Delayed ART initiation status of HIV-positive adults receiving ART at public health institutions in Bahirdar city, Northwest Ethiopia, 2021
Figure 2. ROC curve graph showing model discrimination power among adults receiving ART following Test and Treat strategy at FHCSH, Northwest Ethiopia, 2021