Socio-Demographic, Economic and Clinical predictors of HAART Adherence Competence for HIV Positive adults at Felege Hiwot Teaching and Specialized Hospital, North West Ethiopia

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Abstract
Background: Currently, around 36.7 million people in the world are living with HIV. Among these, 52% are living in sub-Saharan African. Antiretroviral therapy (ART) has played an important role in improving the prognosis and quality of life of HIV/AIDS patients, and in reducing the rate of disease progression and death. Several previous researches on factors affecting HAART adherence competence had controversies. As far as the author’s knowledge concerned, no research had been conducted on longitudinal HAART adherence competence in the study area. The main objective of this study was to identify Socio-demographic and Clinical factors associated with HAART adherence competence in successive visits among adult HIV patients after commencement of HAART.

Methods: A retrospective cohort study on 792 HAART attendants was conducted to analyze the current study for HIV positive adults who had a minimum of two clinical visits. Secondary data were employed to examine Socio-demographic, economic, individual and clinical factors affecting the variable of interest overtime among HAART users. The Structural Equation modeling (SEM) was applied to identify predictors of HAART adherence competence over time.

Results: In this longitudinal study, factors affecting long-term HAART adherence competence in successive visits had been identified. Socio-demographic factors (like Marital status, level of disclosure of the disease, residence area, education, economic factors (owner ship of cell phone, household income), individual factors (age, sex, weight) and clinical factors (CD4 cell count, WHO stages), directly associated with retention of HAART medication care. On the other hand, HAART medication care was significantly and independently associated with the longitudinal HAART adherence competence.

Conclusion: The HAART adherence competence in successive visits increased with the number of follow-up visits, but the rate of increase was different for different groups such as male & female, urban & rural, and disclosing & hiding the disease to family members. An integrated health related education should be given for poor adherent patients like rural residents, males, patients living without partners, patients with no cell phone and aged patients.

Background
Now in these days, around 36.7 million people in the world are living with HIV. Among these 52% are living in sub-Saharan African[1]. The rapid scale up of antiretroviral treatment (ART) in Sub-Saharan Africa (SSA) has resulted in an increased focus on patient adherence[2]. With the introduction of antiretroviral therapies (ARTs), HIV is increasingly becoming a chronic and manageable disease[3]. Hence, about 17 million people in the world are taking ART in these days. More than 50% of such people are living in Sub-Saharan Africa. Ethiopia, one of the east-African countries is highly affected by the epidemic with a prevalence rate of 1.5% [4]. Felege Hiwot Teaching and Specialized Hospital in Amhara region, Ethiopia is the referral hospital giving ART services for about 6 thousand HIV Positive individuals[5].

Non-adherence can lead to drug-resistant HIV caused by failure to achieve maximal viral suppression. Optimal treatment requires the identification of patients at high risk of suboptimal adherence and targeted interventions. Identifying socio-demographic and clinical predictors of HAART adherence competence among HIV-positive adults helps for sustainable supply of ART to clinics and lifelong adherence to treatment by patients. The importance of improving treatment adherence has resulted in a vast number of publications focusing on this topic.

A continuous spread of first-line ART-resistant HIV strains increases demand for second-line treatment often associated with poorer patient health outcomes and increasing healthcare costs. For these reasons and others, a thorough understanding of factors associated with HAART adherence competence is paramount. Recently conducted studies on HAART adherence competence showed that predictors and risk factors differ per region of the world, necessitating situation-specific development of non-adherence profiles. This enables healthcare providers to offer tailored care for patients at risk of non-adherent patients. HAART adherence improves health conditions and prolongs the lives of persons with HIV, it also decreases viral load, HIV/AIDS related morbidity and mortality[6]. Access to ART has rapidly expanded globally and in Sub Saharan Africa especially to allow early treatment for HIV infected individuals[7]. However, implementation of HAART adherence competence had been affected by the various factors and faces major challenges[7]. Better socio-demographic status and well tolerated regimens are associated with better HAART adherence. Other factors like economic and
socio-cultural factors, patients’ knowledge of their HIV status and psycho-social factors (stress, depression and anxiety) have also been associated with pediatric HAART adherence competence [8]. Previous findings had a certain controversies with regard to the initiation of HAART adherence for HIV patients. Many of HIV patients who started the therapy with a small number of baseline CD4 cells count did not recover to a normal CD4 cells count even after long term HAART adherence competence[9]. Many studies had been conducted about factors affecting HAART adherence in Sub-Saharan African countries like Ethiopia, Uganda, Zimbabwe and South Africa[10, 11]. However, some of these studies were cross-sectional and did not assess the HAART adherence competence level over time [12], and some of the others did not assess the latent variables that cannot be measured directly but have significant effect for performance of HAART adherence competence [13–15]. These studies lack multivariate analysis including the latent variables among socio-demographic, economic, clinical and individual factors. The retention of medication care( measured using follow up visits) should be also assessed its effect on the progress of HAART adherence competence.

A cross-sectional study was conducted on the analysis of social, demographic, behavioral, economic and clinical factors affecting first month adherence for the same set of data [12]. Although factors associated with first month adherence gave important information, factors affected long-term HAART adherence competence revealed more relevant information, as repeated observations on the variable of interest is more reliable as compared to cross sectional studies. Therefore, it is important to reconsider socio-demographic and clinical factors affecting the HAART adherence competence in successive visits. There is a scarcity of literature that evaluates latent variables/relationships between factors affecting adherence to HAART in successive visits over time; hence, this gap became an initiation for the current research.

The objective of this study was to identify socio-demographic, economic, clinical and individual factors associated with HAART adherence competence among HIV-positive adults at Felege Hiwot teaching and specialized Hospital, North West Ethiopia. Having information about determinants of HAART adherence competence in successive visits helps both health service providers and patients to make the initiation and continuation of the program, and to run proper management and monitoring of
Methods

Study design and setting

A retrospective longitudinal study design was conducted at Felege Hiwot Teaching and Specialized Hospital, Amhara region located in north-western part of Ethiopia. A random sample of 792 adult patients who commenced their HAART adherence was included under investigation. The sampled patients were selected using stratified random sampling technique considering their residence as strata. The data used in current investigation were secondary and collected from the charts of the selected patients. The data were collected by health care givers while patients visit the hospital for re-filling pills for the following months and to test their health status (progress of CD4 cell count and HAART adherence competence) by care givers. The data analyzed in the current investigation consists of a retrospective evaluation of patients’ record in the hospital whose follow-ups were between September 2012 and August 2017.

In the hospital, during the initial period of HAART, patients visited the hospital weekly for a month. Subsequently, patients visited the hospital monthly for five months in successive visits. Thereafter, patients visited the hospital quarterly for medical examination of HAART adherence competence (measured using pill count) and for diagnosis of CD4 cell count. Patients in the hospital received regimens containing two nucleoside reverse transcriptase inhibitors and one non-nucleoside reverse transcriptase inhibitor. The hospital delivered different regimens for patients in the urban and rural areas. The reason for this was, it can be co-administered with anti-tuberculosis (TB) medication. Information related to HIV/AIDS at each visiting time of patients was recorded on data collection sheet prepared by the Ministry of Health. The quality of data was controlled by ART section in the hospital.

Variables under investigation

The variable of interest, the HAART adherence competence in successive visits measured frequently using Pill count and self reported adherence performance. Hence, the outcome/response variable was HAART adherence competence in successive visits.

**Predictor variables:** Time invariant predictors under this investigation include sex (male, female),
residence area (urban, rural), level of education (no education, primary, secondary and tertiary), ownership of cell phone (yes, no), marital status (living with partner, living without partner), level of income (low, middle and high), WHO stages (stage1, stage2, stage3 and stage4), disclosure of the disease (yes, no), age in years, and CD4 cells count in cells/mm3 obtained at initial of HAART. Visiting times were taken as count response variable consisting of value 1 for the first visit, 2 for the second visit, and 23 for the twenty third follow-up visits. HAART Adherence was measured every visiting time using pills count and patients were categorized as adherent or non-adherent. A patient is said to be adherent if he/she took at least 95% of the prescribed medication. He/she would be considered as non-adherent if he/she took less than 95 % of the prescribed medication. The other time variant covariate included under this investigation was weight in kilograms measured in every visit.

*Inclusion and exclusion criteria:* The number of follow-ups and age were the criteria used for including or excluding patients in this study. Adult patients, who had started HAART with a minimum of two follow-ups, were included in this investigation. However, patients with less than two follow-ups and children under age 15 were excluded.

*Sample size and sampling:* A random samples of 792 patients were selected using stratified random sampling technique considering their residence area as strata. In calculating the sample size, 95% CI and 5% margin of error were taken in to account. Assuming that 10% of the respondents’ chart being incomplete, the determined sample size was multiplied by 2 to consider the effect of the strata and to increase the power of precision. Moreover, attempts were made to compute the required sample size by employing two population proportion techniques. However, all were found below 792. Therefore, 792 samples were taken as the final sample size.

*Data analysis:* Data were entered and analyzed using AMOS and SAS (version9.2). Dummy variables were created in the case of categorical variables. Structural Equation modeling (SEM) was used for assessing factors affecting HAART adherence Competence in successive visits over time with the inclusion of correlated data obtained in repeated measures. SEMs were also used to assess the analysis of patients with different number of visiting times [16].
SEMs are applied to evaluate latent variables and call upon an evaluation model that refers to latent variables applying one or more observable variable[17]. The most significant demographic, economic, individual and clinical determinants of CD4 cell count change in HIV positive adults who initiated HAART described as follows.

Socio-demographic factors were measured using recorded data related to educational status of adult patients, residence area of patients, marital status of patients, and disclosure of the disease to family members living together.

Education is to a large extent correlated with income, and much of the complexity that is evident in the relationship between income and HIV prevalence is thus also evident in the relationship between education and HIV prevalence. Therefore, socio-demographic disadvantageous HIV positive adults are less likely to know what AIDS is and had less follow ups on their prescribed medication (HAART adherence competence) and this further associated to lower CD4 cell count change [18, 19].

The social factors for current investigation were related to disclosure level of the disease and marital status of patients. The relationship between marital status and HIV infection is complex. Hence, the risk of HIV prevalence remained significantly high among unmarried compared with married people when only sex behavior factors are controlled for the given model[20].

The economic factors are related to level of income and ownership of cell phone. Income can be defined in terms of individual income or household income. There are a number of arguments that the relationship between income and risk factors of HIV infection in general and HAART adherence competence in particular is higher among the poor, but there are also several to explain why patterns of infection may be the other way around. Hence, previous researches indicate that poor tends to be exposed to greater dangers in the course of their everyday life than the relatively wealthy[21].

The individual factors were related to age of patients, sex of patients, and weight of patients. In the previous research, it is indicated that patients aged 40 years and above presented lower rates of CD4 increase over the period of the cohort and this is associated to low HAART adherence competence [22, 23].

The clinical variables, are highly associated with level of CD4 cell count and WHO stages of patients at
each follow-up visits and potentially helpful in the identification of patients at risk for rapid progression of HIV[23]. Hence, identifying such patients early in the clinical course of HIV disease progression helps to reduce and control risk factors for rapid progression of the disease by both health workers and patients as well. Different researches conducted recently declared that HAART adherence competence is strongly associated with obtaining optimal CD4 cell count change compared to non-adherence [24]. The adherence level of patients are highly affected with level of income such that patients with high level of income had good competence level of adherence [25]. The real HAART adherence competence was measured using clinical factors (self reported adherence and pills counts) which were recorded in the charts of patients.

Similarly, retention in HAART medication care was measured using time of follow up visits. It is the time period an individual to visit the hospital to re-fill the pills for the next months. Thus, it is said that a person is HAART adherence competent when he/she uses those resources to do what is expected, as would be the case in consuming medication as prescribed [26]. Retention in HIV medication care is a crucial activity and furthermore, HAART adherence competence is a primary need for achieving long term survival with HIV infection [27]. HIV care guideline also recognizes the importance of retention in HIV care as a precursor to adherence [28]. Successful strategies to improve retention in HIV care and HAART adherence competence to require an understanding of retention and adherence behavior and the complex interplay between biological, psychological, behavioral, social and health systems drivers [29].

The hypothetical relations between variables for the prediction of medication adherence behaviors are indicated in Figure1. In Figure1, a direct influence of the variables of socio-demographic and economic variables, social and clinical factors on HAART medication care was expected. On the other hand, HAART medication care measured using follow-up visiting of patients was expected to have direct effect on HAART adherence competence.

The goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were assessed using PROC CALIS in SAS software. To test for the goodness of fit of the given model, socio-demographic, economic,
individual and clinical characteristics were considered as latent variables on the first model. Similarly, retention on HAART medication care was considered as latent variables for the second model. Data analysis was carried out to obtain descriptive statistics means and standard deviations (SD) for each of the independent variables. The correlation structure was also conducted to test the association of each predictor variables.

Figure 1: Hypothetical model of relationship between observed and latent variables with the variable of interest (HAART adherence competence)

Figure 1 indicates a network of relationships of measurement model that connects the observed exogenous and endogenous variables. In Figure 1, the observed variables for socio-demographic factors; literate, urban, living with partner and disclosed the disease were dummy variables for level of education, residence area, marital status and disclosure level of the disease respectively. Similarly, observed variables related to economic factors, patients with high income and with ownership of cell phone were dummy variables for level of income and ownership of cell phone respectively. Observed factors associated with individual characteristics were; male patients belong to dummy variable for sex of patients. Finally, the observed variable, not WHO stage4 stands for dummy variable for WHO stages. The relationship between observed and latent variables was constructed using AMOS software version 22 and parameter estimation for direct and indirect effects indicated in Figure 2 was conducted using PROC CALIS in SAS software.

Results
The estimates were conducted using maximum likelihood estimation technique. Hence, $|C.R| = \frac{|Estimates/S.E|}{|Estimates/S.E|}$ was greater than 1.96 for 0.05 level of confidence and greater than 2.56 for 0.01 level of confidence for all covariates and this further indicates that parameter estimates by all covariates under investigation were statistically significant [30, 31]. The mean and variance of exogenous variables are indicated in Table 1.

The magnitude of mean and standard deviation for each exogenous variable indicates that standard deviation was greater than mean for all variables and this is an indication that distribution was over dispersed.
The correlation structure of these observed variables is also indicated in Table 2.

As it is indicated in Figure 2, there was direct and significant effect of observed predictor variables on the latent variables (Socio-demographic, economic, individual and clinical factors). Hence, the observed variables obtained from charts of patients directly and significantly affected socio-demographic, economic and clinical factors. On the other hand, socio-demographic, economic and individual characteristics had direct and significant effect on the retention of patients in the HAART medication care.

Considering the hypothetical relationships described in Figure 2, in the first model, recorded variables obtained in the hospital were categorized as socio-demographic, economic, individual characteristics and clinical factors. Some of the significant variables in this model were literate (w1 = 2.04; variance = 0.81, p = 0.012), patients living in urban area (w2 = 3.97, variance = 0.6; p = 0.021), patients living with partners (w3 = 8.16, variance = 0.62, p = 0.024), patients disclosed the disease to family members (w4 = 6.24, variance = 0.29, p = 0.012), high income (w5 = 6.37, variance = 0.53; p = 0.002), ownership of cell phone (w6 = 2.99, variance = 0.68, p = 0.034), weight (w7 = -2.89, variance = 0.29, p = 0.001), age of patients (w8 = -2.78, variance = 56.64, p = 0.023), male patients (w9 = -1.25, variance = 0.88, p = 0.036). CD4 cell count (w10 = 2.57, variance = 158.48, p = 0.015), not WHO stage 4 (w11 = 2.37, variance = 0.78, p = 0.026) and first month adherence level (w12 = 3.07, variance = 0.72, p = 0.034)

Similarly, on the second model, socio-demographic factors, economic factors, individual characteristics and clinical factors were statistically and independently affected the retention of medication adherence. Follow-up visits of patients were also significantly associated with retention of medication care. Finally, on the third model, retention medication care significantly and statistically associated with the variable of interest (HAART adherence medication)

Hence, the above significances indicate that there was direct relation between socio-demographic, economic, individual and clinical variables with retention of HIV positive individuals in HAART medication program. The result also indicates that there was direct and significant effect of retention medication care and HAART adherence competence. This result further indicates that, socio-
demographic, economic, individual and clinical characteristics statistically and indirectly affected the HAART adherence competence.

The longevity/retention of patients in the HAART medication care program had also direct and significant effect on the competence of HAART adherence ($w187 = 3.46; p < 0.01$).

The results obtained from the given data indicated that the model was acceptable fit on CFI (0.965). Unacceptable fit was found with chi-square ($39.67; p$-value $< 0.0001$) and RMSEA (0.218). However, the covariate model found acceptable for CFI (0.994), RMSEA (0.001) and unacceptable for chi-square (40.23, $p$-value $< 0.0001$).

**Figure 2:** Path Analysis of predictor variables for CD4 cell count change after estimates of parameters and error terms

In the estimation of the covariance structure, the following important (key) indicators of goodness-of-fit were provided that chi-square $= 983.45$, with $p$-value for chi-square $< 0.01$, which indicates that the chi-square statistic is not closer to zero and the corresponding $p$-value is very small (significant), which is an indicator of weak fit. This indicates that the model is inadequate. However, RMSEA was estimated to be 0.01, CFI = 0.97, Non-normed fit index (NNFI) = 0.96 and NFI = 0.95. Hence, RMSEA, CFI and NFI assured for the model to be good fit.

**Discussion**

Consistent with results from recent longitudinal studies [32], the findings in this study showed that the HAART adherence competence improved through time. This indicates that the interventions on program may have had a positive effect on HAART adherence competence. The HAART adherence competence at initiation of HAART was similar for male and female patients; however, as visiting time increased, the variable of interest was higher for females than that of males. The reason for this disparity might be because of females’ good experience on adherence of pills for birth control [33, 34]. Hence, it is possible to assume that women have been more responsible for care-giving duties and adopting the behavior of taking pills at all times [33, 35]. This behavior of high HAART adherence response in females leads to become better healthy looking.

Recent studies have consistently indicated that demographic characteristics such as age had
significant association with the HAART adherence competence [32]. Hence, as age of a patient increased, the HAART adherence competence decreased. Current investigation also indicated that treatment was less effective for old age patients as compared to youngsters. This result confirms the literature that states immune function decreases with an increase of age.

The importance of early diagnosis to initiate HAART was indicated in this study. Patients who started HAART with high baseline CD4 cells count increased the absolute difference in CD4 cells count as compared to those patients initiated with low baseline CD4 cells count. This encourages patients to be HAART adherent. This result agrees with findings obtained from other similar studies [36, 37], and contradicts with still other findings [38]. Patients living with partners had better HAART adherence competence as compared to those living without partners. This might be because partners living together support each other in using the prescribed medication or remind each other the time to take pills and visit the hospital. This result contradicts with previous study [32] and is supported by another study [39].

The HAART adherence competence in successive visits for urban patients was greater as compared to rural residents. The reason for this might be that rural patients come for HIV diagnosis lately after destruction of CD4 cells count. Besides, their distance from hospital may have its own impact for late diagnosis. Another reason might be rural patients may not have regular checkup or HIV diagnosis; and most of them come to hospital after severity of illness. This finding agrees with another previous research [32].

Education had significant effect on the variable of interest in this study. More educated patients may easily understand the use of proper adherence [40] for progression of absolute difference in CD4 cells count as compared to non-educated patients. As visiting time /follow-up visits increased, the absolute difference in CD4 cells count also increased; and this result further leads to be HAART adherent [41].

The economic factors such as patients with cell phone and those who have high income associate with high retention in the medication care. Hence, patients with high income may use different alternatives to get pills and he/she also uses proper food adherence schedules for the treatment to be effective and this encourages the patient to attend the visits of health institution[42]. Cell phone of
patients can play significant role in taking pills on time and to remind the date that the patient should visit the hospital. Cell phone helped patients to be HAART adherent because of its alarm (memory aid) for reminding the time pills are taken [43]. This finding is consistent with findings from another study [44] and suggests the need for making cell phones available to the needy HAART attendants. This finding is consistent with previously conducted research[45].

Clinical factors such as patients’ CD4 cells count significantly affected their retention of medication care. Patients with high number of CD4 cell count encouraged the patient to be HAART adherent as compared to patients with less number of CD4 cell count[38, 44, 46, 47]. This result indicates that clinical factors (CD4 cell count and WHO stages) positively associated with retention of medication care.

Conclusion
The analysis in the current investigation identified a certain group of patients, such as males and rural residents, patients without owner of cells phone, patients living without partners and aged patients were a relatively maximum risk of treatment response. Poor adherent patients had low results in the variable of interests which indicates that adherence to HAART and the absolute difference in CD4 cells count are positively correlated to each other. Patients with good performance of adherence to HAART had better absolute difference in CD4 cells count. The current study indicated that the HAART adherence competence increased over time. However, its progress was different for different groups. Consequently, due attention should be given to address the specific needs of each group of patients. Non-adherent patients in this long-term treatment program were at risk and should receive interventional treatment. Health related education should be given to patients to initiate HAART before reaching its cut-off-point (<200 cells/mm3) for easy recovery to normal situation (>500 cells/mm3) [32, 34]. Single intervention strategy cannot improve risks of non-adherent patients. Many studies corroborate that successful attempts to improve patients’ HAART adherence competence depend upon a set of key factors. These include realistic assessment of patients’ knowledge/level of education and understanding of the regimen, residence area of patients, age and sex of patients. The research endeavored to identify certain groups that require special attention; and this helps to
intervene in HAART activities which elongate patients’ lives.

This study had certain limitations. One of the limitations is that the data were taken in one treatment site. Considering two or more sites in the investigation may have additional information; further study on the variable of interest in successive visits and its determinants with additional sites is recommended.

List Of Abbreviation

HAART = Highly Active Retroviral Therapy, RMSEA = Residual Mean square error approximation, CFI = Comparative Fit Index, NNFI = Non-normed fit index, NFI = Normal Fit Index, GFI = Goodness of Fit Statistic, AGFI = adjusted goodness of statistic, RMR = Root mean square residual

Declarations

Ethical approval and consent for participate: The data used in current investigation was collected previously by the health staff for treatment purpose/for diagnosis of HIV/AIDS and to start ART. To use this previously collected data, Ethical approval certificate had been obtained from Bahir Dar University Ethical approval committee, Bahir Dar University, Ethiopia with reference number: RCS/1412/2012.

Consent form for participants: In data collection, there was no written or verbal consent from participants. The reason was, investigator didn’t get participants, rather secondary data was obtained in patients’ chart. The Ethical approval committees approved for the use of this secondary data for current investigation.

Consent for publication: This manuscript has not been published elsewhere and is not under consideration by any other journal. Hence, the author approved the final manuscript and agreed with its submission.

Availability of data and materials: The Author confirmed that the data used for this research is available with him.

Competing interests: There is no financial and non-financial competing interest between the author and institutions.

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Tables

Table 1: Mean and Variance of exogenous variables

| Variable           | Mean    | Std      |
|--------------------|---------|----------|
| literate           | 0.80965 | 0.8998   |
| With partner       | 0.59807 | 0.77335  |
| urban              | 0.61356 | 0.7833   |
| disclosed          | 0.29349 | 0.54174  |
| High income        | 0.13662 | 0.36962  |
| Owner of cell phone| 0.55587 | 0.74557  |
| age                | 73.28275| 75.13789 |
| weight             | 63.71277| 65.37255 |
| male               | 0.49042 | 0.7003   |
| CD4 cell count     | 157.02836| 187.47603|
| notstage4          | 0.78379 | 0.88532  |
| Visiting time      | 11.44517| 13.20341 |

Table 2: Correlation structure of exogenous variables
|   | 1    | 2   | 3   | 4    | 5   | 6   | 7   | 8   | 9   | 10  | 11  |
|---|------|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|
| 1 | literate | 1.000 |     |      |     |     |     |     |     |     |     |
| 2 | withpt | 0.253 | 1.000 |     |     |     |     |     |     |     |     |
| 3 | urban | 0.061 | 0.010 | 1.000 |     |     |     |     |     |     |     |
| 4 | discld | 0.172 | 0.463 | 0.032 | 1.000 |     |     |     |     |     |     |
| 5 | high | 0.121 | 0.319 | 0.040 | 0.3156 | 1.000 |     |     |     |     |     |
| 6 | owner | 0.024 | 0.475 | 0.015 | 0.5262 | 0.347 | 1.000 |     |     |     |     |
| 7 | age | -0.166 | -0.633 | -0.017 | -0.726 | -0.681 | -0.611 | 1.000 |     |     |     |
| 8 | weight | 0.211 | 0.198 | 0.024 | 0.1485 | 0.141 | 0.138 | -0.183 | 1.000 |     |     |
| 9 | male | -0.019 | -0.086 | -0.002 | -0.031 | -0.004 | 0.064 | -0.068 | -0.061 | 1.000 |     |
| 10 | initial | 0.191 | 0.742 | 0.009 | 0.2541 | 0.563 | 0.287 | -0.193 | 0.242 | -0.090 | 1.000 |
| 11 | adhe | 0.188 | 0.524 | 0.028 | 0.1451 | 0.258 | 0.138 | 0.257 | 0.196 | 0.031 | 0.701 |
| 12 | notst4 | 0.089 | 0.405 | 0.027 | -0.463 | 0.420 | 0.455 | 0.240 | -0.602 | 0.019 | -0.114 |
| 13 | vistim | 0.026 | 0.049 | 0.036 | 0.1361 | 0.051 | 0.090 | 0.038 | 0.258 | -0.006 | 0.040 |
| 14 | CD4c | 0.171 | 0.553 | 0.065 | 0.742 | 0.708 | 0.547 | -0.365 | 0.195 | -0.069 | 0.273 |

Figures
Figure 1

Hypothetical model of relationship between observed and latent variables with the variable of interest (HAART adherence competence)
Figure 2

Path Analysis of predictor variables for CD4 cell count change after estimates of parameters and error terms.