

Addis Ababa University
College of Health Science
School of Public Health



Cost and Cost-Effectiveness of Facility, Standalone and Mobile
Based VCT in Addis Ababa, Ethiopia

By: Amanuel Lulu

Advisor: Alemayehu Desalegne (PHD fellow)

A Thesis Submitted to the School of Public Health at Addis Ababa
University in the Partial Fulfillment of the Requirements for the
Degree of Masters of public health in Health Economics

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti-Retroviral Therapy
CD4	Cluster of Differentiation 4
CEA	Cost-Effectiveness Analysis
EFY	Ethiopian Fiscal Year
FSW	Female Sex Workers
HTC	HIV Testing and Counseling
HAPCO	HIV AIDS Prevention and Control Office
ICER	Incremental Cost Effectiveness Ratio
INMB	Incremental Net Monetary Benefit
OSSA	Organization for Social Service and Development
PICT	Provider Initiated Counseling and Testing
PSA	Probabilistic Sensitivity Analysis
SNNPR	Southern Nations, Nationalities, and Peoples' Region
US	United States
UNAIDS	Joint United Nations Program on HIV/AIDS
USAID	United States Agency for International Development
VCT	Voluntary Counseling and Testing
WHO	World Health Organization

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Abstract

Background: Early diagnosis of HIV virus is a determinant for effective treatment of the disease with less costs than a late treatment. Mobile based VCT as part of community HIV testing and counselling service is suited to highly populated settings. Recently the world has agreement on UNAIDS 90-90-90 goals to achieve 90% of people living with HIV to know their HIV status by 2020 and end the AIDS epidemic by 2030. Despite the agreement, HIV testing and counselling continues to be undertaken predominantly in health facilities, even if there is strong evidence on clients' preference to test in the community. Hence, empirically studied cost-effective HIV testing and counselling model is desirable to achieve the goal.

Objective: The objective of this study is to describe the cost and compare the cost-effectiveness of Facility, Standalone and Mobile based VCT in Addis Ababa, Ethiopia.

Methods: Ingredients costing method and reciprocal cost allocation approach based on a provider perspective in view of economic costs was performed from July 2016 to June 2017 (2009 EFY). Effectiveness is measured by HIV-seropositive individual identified. A cross sectional study design using Decision tree modelling on TreeAge 2018 software was performed. One way and Probabilistic sensitivity analysis were conducted on HIV prevalence, costs, and probabilities.

Result: The mean cost per client tested for HIV in Facility, Standalone and Mobile based VCT are USD 4.9, 6.6 and 3.7 respectively. The mean cost per HIV seropositive client identified for the corresponding models are USD 153.6, 154.1 and 138.8 respectively. From the three models, Standalone based VCT is extendedly dominated. The incremental cost of Mobile based VCT is USD 192.1 for every additional HIV positive clients identified when compared to Facility based VCT.

Conclusion: More resources should be allocated to HIV prevention through mobile testing to eliminate HIV transmission and start ART early in the disease progression as Mobile based VCT is effective in diagnosing higher number of HIV positive individuals than Facility based VCT with higher costs. As the HIV prevalence in Ethiopia is becoming more concentrated in urban areas, more effort should be made for the provision of HIV counseling and testing service by implementing testing through Mobile based VCT to reach the 90-90-90 goal set by UNAIDS.

Key words: Ingredients costing, decision tree modelling, reciprocal cost allocation, cost effectiveness analysis, and VCT models

1. Introduction

1.1 Background

HIV is one of the most devastating global epidemic diseases in the recent history. Since the beginning of the epidemic, estimated number of 78 million people have been infected with the virus and over 35 million people have died of it. It is estimated that 42 million people are living with HIV/AIDS of which 19.4 million are living in east and South Africa at the end of 2016. The number of new HIV infections in 2016 was 1.8 million worldwide. Sub-Saharan Africa accounts for three quarters of all these new infections and HIV related deaths. Two third of global community and only half of Africans know their HIV status (1-3).

To reduce the prevalence and impact of HIV/AIDS, a new targets are set by UNAIDS known as 90-90-90 goal, which are for 90 % of people living with HIV to know their status by 2020, with 90 % of these retained on antiretroviral therapy (ART), and 90 % of those on ART to have undetectable viral loads (4). The modelling shows that if 90-90-90 goal is achieved by 2020, it will help to end the epidemic by 2030 which will have profound economic and health benefits. To achieve this target, awareness of HIV status through HIV testing and counseling is key to ensure timely access to effective HIV treatment and reinforce prevention of new infection among the negatives. So far Ethiopia has achieved 67% in HIV-seropositive people knowing their status and 85-89% in putting HIV-seropositive people on ART and those on ART to have undetectable viral load, still a lot to do in achieving the 90% knowledge on HIV status for the HIV positives (4, 5).

In Ethiopia the current HIV testing and counselling (HTC) service delivery models are classified into four. They are: 1) Integrated (Facility) HTC services: provided in public, NGO and private health facility settings, and are classified into Facility based VCT (HIV testing and counseling conducted in health facilities initiated by the clients) and provider initiated testing and counselling (PITC), 2) Standalone VCT (standalone HTC), 3) Outreach and mobile VCT (outreach and mobile HTC), and 4) Work place HTC service (6).

HIV testing and counseling service is generally established on community based and facility based HIV testing and counseling approaches. Community based HTC was defined as testing conducted outside of health facilities (outreach and mobile, workplace, home). Facility based HTC is testing conducted in healthcare facilities (7). Community based HTC reaches more first-time testers and HIV positive individuals with high CD4 cell counts, i.e., reach HIV infected individuals earlier in their disease progression (8), potentially improving health

outcomes than Facility based HTC (9). Community based HTC may be essential to reach the 90-90-90 target, although they have lower uptake of post-test HIV care service and costs tending to be higher than for facility based HTC services. Facilitated linkage interventions to care should be provided alongside with the community based HTC (10, 11). Community based HTC with mobilization and enhanced linkage to care has the potential to overcome barriers to HIV testing and linkage to care, achieving widespread coverage of testing and antiretroviral therapy (12, 13). Community based HTC also relies less heavily on existing infrastructure, allowing easier scale-up (11).

1.2 Statement of the Problem

The number of people tested for HIV in each year is decreasing since 2012 from 11.29 million to 8.40 million people in 2016 (14) and more than half of Ethiopians and 27% of people living in Addis Ababa had never been tested until 2016 (15). The estimated numbers of new HIV infection in the same year in Ethiopia is 27,228; urban population were infected three times higher than the rural population, and 6.8% of urban couple and only 0.7% of rural couple were HIV positive (16). Despite the UNAIDS 90-90-90 goals to achieve 90% of people to know their HIV status; VCT service continues to be undertaken predominantly in health facilities (17); even if evidences show that less time, costs and distance are spent by the people on Mobile based VCT than the Facility based HTC (18, 19); and clients' preference to test in the community than in health facilities (20, 21).

The cost of different VCT models vary by: country's economy (22) , the level of training of counsellors, the degree of emphasis placed on careful and intensive counselling, the type of test and number of tests and HIV prevalence (23, 24). In 2016 the adult HIV Prevalence in the country is 1.18% with a regional variation in HIV prevalence of 0.54% in SNNPR and 4.9% in Addis Ababa (14); the choice of VCT models should be guided by this variation. Despite this knowledge, no cost and cost-effectiveness study is conducted on the VCT service delivery model. Therefore this study will inform about the cost and compare cost-effectiveness of Facility, Standalone, and Mobile based VCT in Addis Ababa.

1.3 Significance of the Study

This cost and cost-effectiveness study on HIV voluntary counselling and testing service delivery models will inform providers about the costs of the models and cost-effectiveness of the models by which higher number of HIV-seropositive clients will know their status with less costs to the providers, i.e., to describe the cost and compare cost-effectiveness of the three VCT models in identifying HIV-seropositive individuals. The finding of this study will provide evidence on the best way to conduct VCT service, design appropriate policy and strategy, and to take appropriate actions in the choice of those models to both policy makers and local administrators working on HIV prevention and control. This study will also help those non-governmental bodies working on HIV testing and counseling to shape the direction of their HIV prevention program.

2. Literature Review

2.1 Knowledge of HIV Status and 90-90-90 Goal

The 90-90-90 target is expected to excite national and worldwide activity to control HIV and end the AIDS epidemic. This results in 81% of all HIV positive people on treatment and 73% viral suppression by 2020. Meeting those objectives makes it achievable to end the AIDS epidemic by 2030. Some believe, in numerous nations, continuation of the present pace of HIV testing will abandon them well short of the 90-90-90 milestones although more than half (53%) of people living with HIV are on ART treatment for the first time due to the target. Verifiably, for the entire world, the pace of scale-up of HIV testing service must accelerate if we are to achieve the objective of 90% knowledge of HIV status among people living with HIV (25-27).

At the end of 2017, knowledge of HIV status among people living with HIV in Asia, and Pacific and Latin American countries are 71% and 81% respectively. The corresponding percentage for East Europe and central Asia, western and central Europe and North America, Caribbean, and Middle East and North African countries are 63%, 87%, 58% and 64% respectively. In Western and central African countries, knowledge of HIV status among people living with HIV is 42% on average (Congo with least percentage of 29% and Gabon with the highest percentage of 79%) (26, 28).

In Eastern and South African countries; knowledge of HIV status among all individuals living with HIV is low in Madagascar (7%), Comoros (38%), and Angola (40%); and highest in Rwanda (87%), Botswana (86%) and South Africa (85%) toward the finish of 2017. On average, 76% of people who are infected with HIV already know their HIV status around the same year (26).

In sub-Saharan African countries; where over 69% of all people living with HIV live, high new HIV infection, greater loss of productivity and mortality because of AIDS is intensely recorded, numerous nations are in transit to achieve 90–90-90 goal. As for awareness of their HIV status, numerous Sub Saharan African nations are advancing great to achieve the 90-90-90 target. 77% of people of Lesotho, 66% of people of Uganda, 52 % of Tanzanians, and 67% Ethiopians who are HIV-seropositive know their status by the end of 2017 (26).

Effort of the world to stimulate HIV prevention and treatment programs are also decreasing the transmission of HIV. The pace of decline in new HIV infections, however, is far too slow

to achieve the Fast-Track Target of less than 500,000 new infections per year by 2020. Report by UNAIDS stated that the pattern in new HIV infection among adults had stayed inert between 2010 and 2015 at 1.9 million for every year. Getting 90% of people with HIV to know their status can subsequently help accomplish the 90-90-90 targets although a recent systematic analysis of national HIV treatment cascades from 69 countries by Levi indicated none of the countries had met the 90% diagnosis of HIV virus. They found that diagnosis ranged from 87% (the Netherlands) to 11% (Yemen) although only a few other countries have achieved the targets. The targets only make sense if HIV counseling and testing identify HIV in people who are not symptomatic and seeking care. It requires taking HIV testing out of the health facilities and into the community which may require new and innovative ways to get people tested for HIV infection. (26, 27).

2.2 Donors have been the main source of funding

The 90-90-90 goal requires 30% of all HIV/ AIDS resources to be allocated to HIV prevention strategies to achieve it. As voluntary counselling and testing is one of the HIV prevention strategies under HTC, sufficient resource should be there to achieve this ambitious goal. Reports from UNAIDS indicate additional USD 6 billion is needed for the success of the goal. Most developing countries including Ethiopia, heavily rely on external fund for their HIV prevention strategies. The US president's emergency plan for relief (PEPFAR) is widely regarded as one of the most effective and efficient foreign assistance programs from USA. The PEPFAR has donated 70 billion dollars to the world in the fight of AIDS, Malaria and Tuberculosis prevention. In 2016 the PEPFAR has donated 5.2 billion dollars for bilateral HIV prevention. As of September 2017, PEPFAR had supported more than 13.3 million men, women, and children on lifesaving antiretroviral treatment (ART). The latest PEPFAR data also show that, for the first time, a significant success is achieved in decreasing new HIV diagnoses by 41% throughout the world. PEPFAR is working to meet the 90-90-90 goal and aims to ensure that 73 percent of all HIV-positive communities are virally suppressed, both for their own health and to reduce the possibility of their transmitting HIV. Due to PEPFAR and the global HIV/AIDS response, modeled data suggest that a cumulative total of nearly 16 million HIV infections globally have been averted since the beginning of the epidemic, including 11.3 million HIV infections in sub-Saharan African countries. (29-31).

2.3 Cost and Cost-Effectiveness Studies on the Models

The comparison of the different studies on cost and cost-effectiveness below include those studies which describe the costing method and measure their outcome in HIV-seropositive individuals identified, clients tested, new HIV-seropositive individuals identified and new clients tested. The literatures describes costs and compare different community based HTC with facility based HTC. Final conclusion is given on the overall review of the literature at the last paragraph.

A study conducted on costs of facility based HIV testing in Malawi, Zambia and Zimbabwe in 2016 showed that the mean cost per client tested for HIV was USD 5.03 in Malawi, 4.2 in Zambia and 8.8 in Zimbabwe. The mean cost per HIV-seropositive individual identified was USD 79.6 in Malawi, 73.6 in Zambia and USD 178.9 in Zimbabwe. Both cost estimates were sensitive to scale of testing, facility staffing levels and the costs of HIV test kits (32). Another study was conducted on Assessing the cost and willingness to pay for voluntary HIV counselling and testing in Kenya in 2002. According to the study the annual cost of VCT in one health center is USD 6800 and the cost of testing one client is USD 8 (33). Study on cost and quality of life analysis of HIV self-testing and facility based HIV testing and counselling in Blantyre, Malawi also showed that the mean health provider cost per client for facility based HTC ranges from USD 7.5 to 10. The cost per HIV-seropositive individual identified through health facilities was ranging from USD 25 to 76 (34).

A study is conducted in Uganda in 2007 on comparing costs and outcomes of four HTC strategies with HIV prevalence of 7.5% in men and 5.0% in women 15–49-year-old. Cost were collected from project account. The study showed facility based HTC diagnosed the greater proportion of HIV infected individuals (27% prevalence), than the standalone HTC (19%). The cost per client tested (2007 USD) was USD 19.2 at Standalone based HTC and USD 11.7 at Facility based HTC; and the cost per HIV-seropositive individual identified for the corresponding sites were USD 100 and 43 respectively. Based on this study, Facility based HTC is more cost-effective in both cost per client tested and cost per HIV-seropositive individual identified than Standalone based HTC (35).

However, a study on expenditure analysis of HIV Testing and Counselling service conducted in Vietnam in 2012 compares the cost-effectiveness of Facility and Standalone based HTC do not support the above findings. The disease prevalence in the country is 0.4% and the cost considered were personnel, building and infrastructure, equipment and durables, test kits and

consumables. The finding shows that cost per person tested is USD 58 at Facility HTC and USD 64 at Standalone based HTC is and respectively. The corresponding cost per HIV-seropositive individual identified is USD 252 and 186 respectively. This study showed Standalone HTC is more cost-effective than Facility based HTC in cost per HIV-seropositive individual identified, but less cost-effective in cost per client tested (36).

A systematic review of HIV testing costs in high and low income settings was conducted in 2015. The review included those studies which reported the proportion of people who were diagnosed HIV-seropositive, the cost per person tested, and information about how these costs were calculated for low to middle income country and high income country. This review indicate that there is a difference in which HTC model might be cost-effective based on the economic status of the country. For developing and middle income countries, the cost per client tested was USD 10 at Facility HTC, USD 20 at Standalone based HTC, and USD 50 at Mobile based HTC. The cost per HIV-seropositive individual identified for Facility, Standalone, and Mobile based HTC were USD 60, 186, and 212 respectively. This review indicated that Facility based HTC is more cost-effective than the Standalone, and Mobile based HTC in both cost per client tested and cost per HIV-seropositive individual identified. This study also indicate that the Standalone HTC is more cost-effective than the Mobile based HTC both in cost per client tested and cost per HIV sero positive individual identified (22) .

A study is conducted on Cost analysis of two community based HIV testing service modalities led by a Non-Governmental Organization in South Africa in 2014. The study compares cost of Standalone and Mobile based VCT and it was conducted from provider perspective. Costs were allocated based on client volume and personnel time. The mean cost per person tested was USD 51 at Standalone and USD 25 Mobile based HTC. In both models, cost of personnel and supplies were the cost drivers and cost of equipment contribute to only few share of the total cost. The study also reported the higher costs of the overheads due to the way the project design is implemented (37).

Similarly, a cost-effectiveness study on increasing access to HIV counseling and testing through Mobile service was conducted in 2007 in Kenya with national HIV prevalence estimate of 9.2% in men and 5.8% in women 15–49 year old. The study uses ingredients costing approach and direct cost allocation methods and demonstrated that the cost of providing HTC through the addition of Mobile services is generally lower than the cost of

Standalone HTC across four different outcomes. Cost per client tested at Standalone HTC was USD 27 and USD 15 at mobile HTC. The cost per HIV-seropositive individual identified for the corresponding sites were USD 189 and 157 respectively. The cost per new client was USD 44 at Standalone and USD 17 at Mobile based HTC. Hence, this study informs Mobile based HTC is an effective strategy for improving HIV counselling and testing access, and is a cost-effective approach for expanding access to HTC services (38).

However, another study which assess the costs of Mobile VCT at the work place versus Facility based voluntary counseling and testing was conducted in Namibia in 2015. The country has population of only 2.1 million with HIV prevalence of 13.4%. The study shows that, the cost per client tested at Facility and Mobile based HTC was USD 58.21 (USD 4,082,936 for the 70, 143 people tested) and USD 60.59 (USD 310,451 for the 5,124 people tested) respectively. The cost per HIV-seropositive individual identified was USD 557 at Facility and USD 578.1 at Mobile based VCT. Unlike the study conducted in Kenya (38) the Mobile based VCT is mounted on truck. The finding of this research shows that the Facility based VCT is more cost-effective than the Mobile based VCT which was explained by the cost input for the mobile VCT (39).

A systematic review and meta-analysis of community and facility based HIV testing to address linkage to care gaps in Sub-Saharan Africa conducted in 2015 estimated the cost of mobile test per client tested to be (US 2012) USD 16.6 and the cost of standalone VCT test per client tested to be USD 36.8. Hospital and clinic HTC had similar costs (USD 12.56 and 12.32, respectively). The review also informed the variation in costs to be dependent on the country where the study was conducted, the costs that were included (start-up or ongoing only) and the intervention scale (40).

The above literatures indicated that, the cost and choice of different VCT service model are determined by the prevalence of HIV, economy of the country, preference of the community, type of resource used, geographical and social accessibility, choice of costing approach, organizational structure, variability in inclusion of costs, and other factors. Therefore, this cost-effectiveness study is crucial to choose the most cost-effective VCT model in Addis Ababa and other urban settings.

2.4 Conceptual Framework

The cost-effectiveness of different VCT service models are determined by their costs and their effectiveness which are affected by different factors. This conceptual framework shows that the models should be cost-effective and assess factors affecting cost and cost-effectiveness of this study.

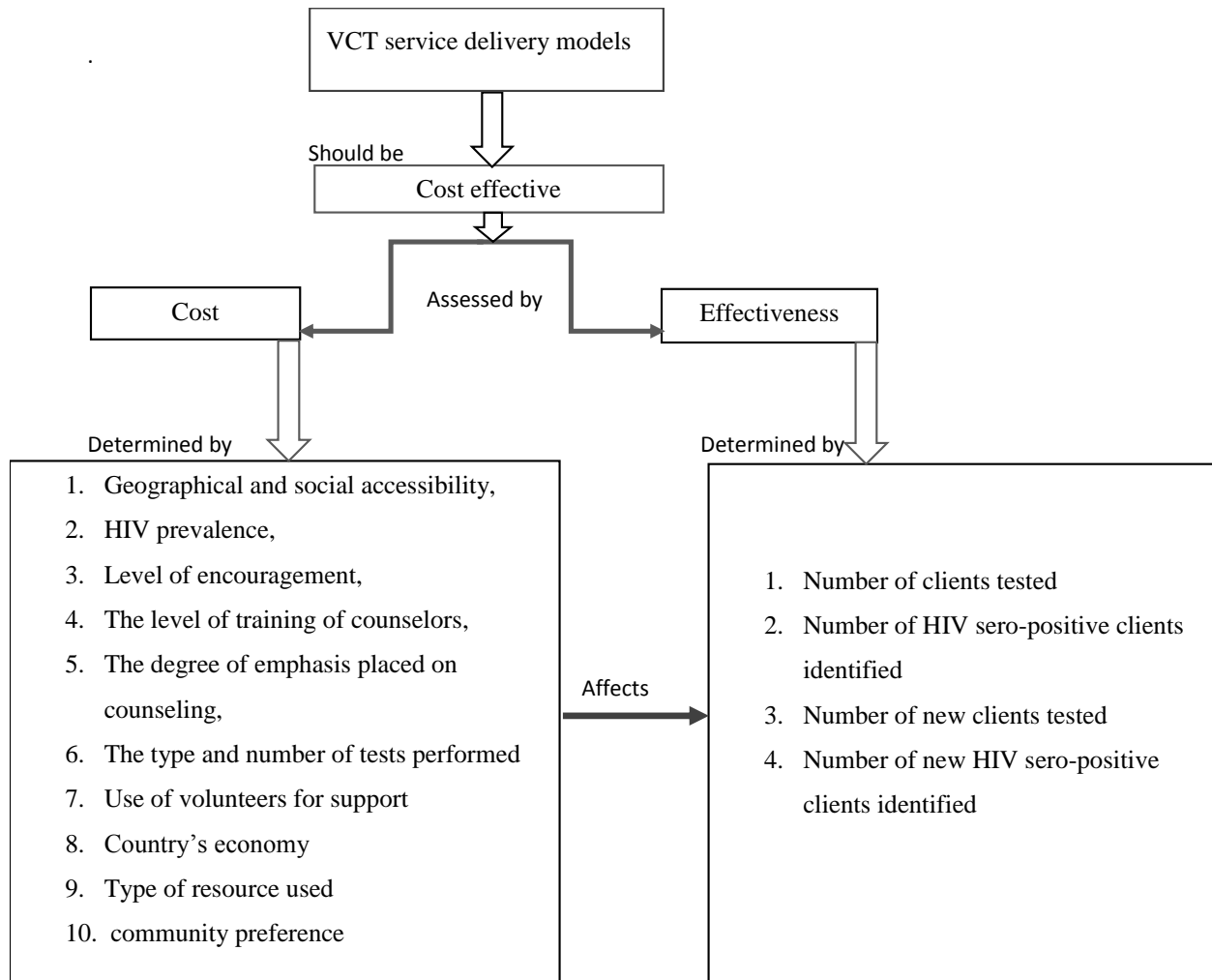


Figure 1: Conceptual framework of the cost and cost-effectiveness study

3. Objective

3.1 General Objective

To describe the cost and compare the cost-effectiveness of Facility, Standalone, and Mobile based VCT in Addis Ababa in 2009 E.F.Y.

3.2 Specific Objectives

- To describe the cost of Facility based VCT
- To describe the cost of Standalone based VCT
- To describe the cost of Mobile based VCT
- To compare cost-effectiveness of Facility, Standalone and Mobile based VCT

4. Methods

4.1 Study Area

This study was conducted in Addis Ababa. Addis Ababa is the capital city of Ethiopia with estimated population of 3.6 million in the city proper and a metro population of more than 4.6 million (41). It has 10 Sub-cities, 117 woredas and 99 kebeles. There are totally 11 hospitals which are owned by the Addis Ababa Health Bureau; 97 health centers, 1 standalone VCT clinic and 15 mobile VCT service sites (operating under AHF Ethiopia). Health service coverage of Addis Ababa with regard to the geographical accessibility is 100%. Currently Addis Ababa is reported to have the highest concentrations of HIV/AIDS cases in the country. The city's HIV prevalence estimate for 2016 was 4.9%, and 16% of the country's new infection in the same year. 27% of the population of Addis Ababa had never been tested for HIV (14). The study setting is health center for Facility based VCT in comparison with standalone and mobile based VCT.

4.2 Study Design and Period

A cross sectional study design using a decision tree model was performed from March to May 2017.

4.3 Source Population

The source population is all VCT service sites in Addis Ababa.

4.4 Study Population

All health centers, standalone and mobile VCT sites in Addis Ababa.

4.5 Sampling Method

To collect cost data from a provider of health services, there are two types of data collection approaches; the center specific and non-center specific approach. The center specific approach collect costs from all service sites while the non-center specific approach may use averaged, single service site or published costs for its source of cost data. For averaged non center specific costing approach, unit cost of selected centers are averaged and generalized for use to other centers (42). Considering the resource available and homogeneity of the health centers with respect to their cost, this study used the Averaged non-center specific

costing for the Facility based VCT by selecting 10 health centers randomly from each sub city. To collect cost data from the standalone and mobile sites, center specific costing approach is used. There is one standalone site; the AIDS Healthcare Foundation (AHF) and 15 mobile sites operating under AHF. the average cost of each VCT model will be taken as cost of one service site for the comparison (24).

4.6 Data Collection Tools and Procedures

The data collection tools are based on the costing guidelines for HIV intervention strategies prepared by UNAIDS (24). The data collection process is coordinated and supervised by hired supervisor, and the principal investigator. A total of 3 individuals were hired; 1 supervisor and 2 data collectors. Training was given before the data collection to all and pretest was conducted on the data collection tools at Mychew health center after the training. The feedback from the pretest was used to correct the data collection tools where necessary and data was collected according to the work plan. The data was collected from review of reports, payrolls fixed asset lists, supply record from NGO and interview with managers, accountants and other responsible bodies. The collected data was reviewed for completeness and consistency by the supervisor and the principal investigator on a daily basis.

4.7 Operational Definitions

Allocation base: the unit of cost measurement for allocation.

Capital costs: cost of resources which will be used for more than one year.

Consumer price index: the current prices of a basket of goods and services in terms of the prices during the same period in a previous year to show effect of inflation on purchasing power.

Exchange rate: Price for which the currency of a country can be exchanged for another country's currency.

Facility (Integrated) based HCT: a type of HCT which includes Facility based VCT and Provider Initiated Counseling and Testing (PICT).

Facility based VCT: HIV testing and counseling conducted in health facilities (hospitals, health centers and private clinics) initiated by the clients.

Fixed cost: is a cost that remains constant, in total, regardless of changes in the level of production output.

Mobile based VCT: a type of community based HCT conducted by setting up a mobile van or container to provide HIV counseling and testing service in a central area of a community.

PITC: HIV testing and counselling conducted in health facilities and recommended during treatment by health care providers to enable specific clinical decisions to be made and/or specific medical services to be offered that would not be possible without knowledge of the person's HIV status.

Recurrent costs: cost of resource which will be used for a maximum of one year.

Replacement cost: Current cash outlay necessary to duplicate an item.

Sensitivity analysis: analysis in which key quantitative assumptions and computations (underlying a decision, estimate, or project) are changed systematically to assess their effect on the final outcome.

Standalone based VCT: a type of HCT service delivery model conducted outside hospitals and health centers as a fixed HIV counseling and testing operating on its own.

Reciprocal cost allocation method: cost allocation method where the cost of overhead departments are allocated to one another before allocating cost to the final cost centers.

Variable cost: A cost that changes in proportion with production output.

4.8 Method of Measuring Costs and Effectiveness

4.8.1 Costing

Facility, Standalone and Mobile based VCT models followed standardized procedures for service delivery. VCT is free, voluntary, and confidential and is delivered by trained counselors after a serial algorithm of rapid HIV antibody tests with finger-prick blood sample collection (43). The choice of different HIV testing and counseling models is based on information from total costs of the service. These total costs are affected by different factors, such as: the geographical and social accessibility of the population, HIV prevalence, the country's economy (22), whether or not particular groups are deliberately encouraged to come for testing, the level of training of counsellors, the degree of emphasis placed on careful and intensive counselling, the number attending relative to the capacity of the service, the type of test and number of tests, the relative importance of the use of volunteers to support some of the activities of the center (23, 24).

Economic costs are used in this study which include the estimated value of goods or services without financial transactions being made or when the price of a specific good did not reflect the cost of using it productively elsewhere (44). The main ways financial and economic costs differ is in the way they treat: donated goods and services, other inputs whose prices are incorrect or distorted, valuation of capital items (24).

This study uses ingredient costing approach to determine costs where by actions to be taken under intervention are listed, specific resources needed to implement the intervention are described, and prices are assigned to all the resources based on opportunity costs used for the intervention (45). The ingredients costing approach has importance in that it distinguish clearly quantities and the prices used to value them rather than to report only total costs or total expenditures. it also allows analysts from one country to more easily assess if costs collected in another country can be used or modified to their settings (46, 47). However, the use of the ingredients approach makes it necessary to determine overhead costs. To estimate the overhead costs, the Reciprocal cost allocation approach was chosen. It fully recognizes mutual services provided among all support service centers and allocate costs between the support service centers before allocating to the direct service center (VCT) (48). Ingredients costing methods and reciprocal method of cost allocation among support centers was used in the costing based on a provider perspective considering economic costs (47, 49) in a time frame from July 2016 to June 2017 (2009 E.F.Y). All the costs were adjusted for inflation using consumer price index of the year 2017 as a base year cost. All costs were expressed in 2017 US Dollars.

Capital costs include buildings, equipment and vehicles which is annualized using a discount rate of 5% with an assumed lifespan of 30 (vehicle) and 5 (equipment) years (24, 50). Because some buildings are older than their expected year of service, others are rented and recently built, rental cost is used for valuing the cost of building to have the same cost comparison. Recurrent costs includes personnel, gloves and test kits, other supplies, vehicle operation and maintenance, and building operation and maintenance. 10% of cost of annual rent was used as annual cost of building operation and maintenance (24).

4.8.2 The Cost Allocation Method

The service sites are health centers, standalone VCT clinic, and mobile VCT site. The service sites are divided into care service center (VCT center) and support service center. Support service centers are divided into ancillary support service centers and site management support

service center. The ancillary support service centers in this study are cleaning and transportation. The site management support service centers are site administration, security, finance, human resources, disease prevention, medical director, counselor coordinator, country program director, accountant, and data clerk. All the capital and recurrent inputs of the support service centers were defined, measured and valued as per the time frame. The total cost for each support service center was then calculated. Considering service output of the support service centers as allocation base, costs were allocated among the support service centers using the reciprocal cost allocation method. After allocating the costs within the support service centers, allocation of the costs from support service centers to the care service center (VCT) were made. Finally, the unit costs and the total costs of the VCT service site was then calculated (51, 52).

Table 1: Recurrent and capital cost components of the VCT service

Recurrent cost	Allocation base	Economic cost		Method of data collection and data source
Personnel	Time worked	Total payment for full time staff, part time staff, and volunteers		Review of annual payroll, and reports and interview
Supplies	Weight/volume	Replacement value		Review of activity, reports and interview
Operation and maintenance of vehicle	Time used and volume	Replacement value		Review of reports and interview
Others		Actual value		
Capital cost			Working life year (source)	
Buildings	Space used	Rental value		interview
Equipment	Time used	Replacement value and annualization	(49)	Review of fixed assets list and interview
Vehicles	Time used	Replacement value and annualization	(49)	Gov't contracts, supply record from NGO, local dealers.

4.8.3 Effectiveness

The choice and nature of outcome measures for HIV prevention studies depend on objective of the project, activities in the project, and output of the project (49).

The outcome measures (effectiveness) are classified into three,

- Primary outcome: measures the final impact on health status due to the intervention of the program;

- Intermediate outcome: happens before there is a health impact and it measures the intermediary changes due to the intervention of the program.
- Immediate (process measure) outcome: measures the activities or outputs of the intervention.

The quality of the measures of effectiveness is determined by; whether the measures are comparable between alternatives, whether it measures the most desirable effects, and sensitiveness of the measure (49, 53).

The intermediate outcome is used for reflecting operational efficiency of intervention program and it is used to identify the most efficient method of delivery under this study (24, 51). Therefore, this study will use the intermediate outcome of HIV-seropositive individual identified.

4.9 Data Analysis

4.9.1 Cost analysis

The analysis of cost is made by a common base year of 2009 E.F.Y for the accumulated cost data of the three VCT models in Microsoft excel by taking a series of steps to allocate them based on the costing and the cost allocation method. The way the cost analysis is made depend on whether the cost were estimated through capital and recurrent input to estimate the unit cost or through the contribution of each support center and calculate the total cost. Descriptive statistics (sum, average and percentile) were used to allocate and estimate the costs.

Overall, the cost analysis include: cost per client tested and cost per HIV-seropositive client identified for service site, capital inputs (equipment and building), and recurrent inputs (personnel salary, glove and test kits, and supplies). The total cost of a VCT site and contribution of support service centers and care service centers to the total cost of a VCT site were also estimated for the three VCT model.

4.9.2 Cost-effectiveness analysis

This cost-effectiveness study of uses decision tree model for analysis (54). Decision tree model is a type of decision analysis model used as a choice of model when an event happen in a short period of time and not recursive. The model follows a series of steps to construct a tree structure under uncertainty for alternative courses of action. Cost- effectiveness analysis using a decision tree model is performed in TreeAge 2018 software. To evaluate the

additional cost per outcome identified, an incremental cost effectiveness ratio (ICER) is reported in cost per HIV sero- positive client identified as payoffs.

4.9.3 Model description

The model structure of the cost-effectiveness study is shown in the figure below.

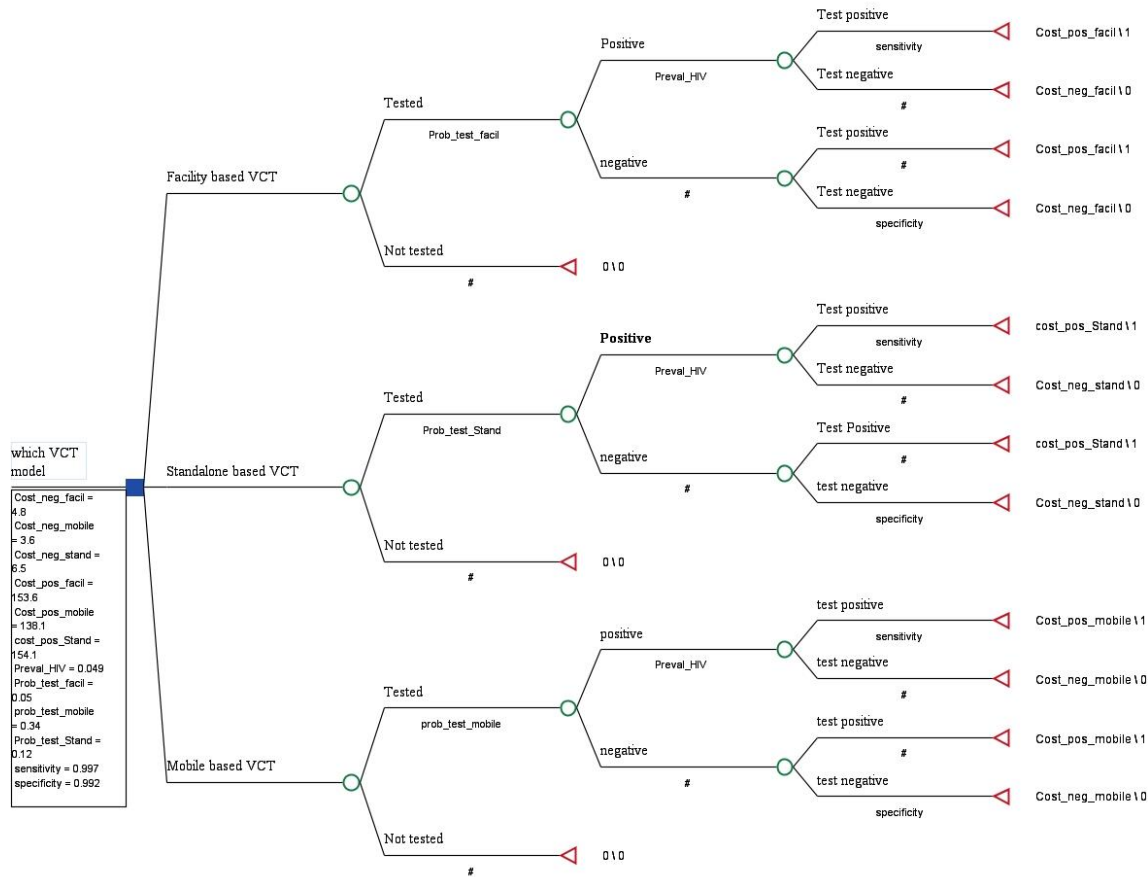


Figure 2: Model structure of the cost-effectiveness study

The input parameters in the tree structure are taken from primary data and literatures. The probability of being tested at a VCT site is calculated by dividing the number of people tested at a site by the estimated population of age above fifteen to be served under that service site. Since there is no information on the expected number of people to be served at a single Standalone and Mobile based VCT, a common catchment population of the Facility based VCT is used for both Standalone and Mobile based VCT. Urban health center serves 40,000 people and the population age group of above 15 is around 57% of total population (55). HIV disease prevalence is used as the probability of being positive. Test sensitivity and test specificity is used for the actual status of the client. Finally, cost per HIV-seropositive and cost per HIV- seronegative were cost payoffs and HIV-seropositive were effectiveness payoff with value of one and HIV-seronegative with value of zero.

Table 2: Input parameters of the cost-effectiveness study

Input parameters	Base value	Low value	High value	Source
Cost of positive for facility VCT	153.6	122.88	187.32	Primary data
Cost of negative for facility VCT	4.8	3.84	5.76	Primary data
Cost of positive for standalone VCT	154.1	123.28	184.92	Primary data
Cost of negative for standalone VCT	6.5	5.2	7.8	Primary data
Cost of positive for mobile VCT	138.1	110.48	165.72	Primary data
Cost of negative for mobile VCT	3.6	2.88	4.32	Primary data
Probability of being tested at Facility VCT	0.05	0.03	0.1	Primary data
Probability of being tested at Standalone VCT	0.12	0.08	0.16	Primary data
Probability of being tested at Mobile VCT	0.34	0.2	0.4	Primary data
Test sensitivity	0.997	0.993	1	(56)
Test specificity	0.992	0.99	1	(56)
Prevalence	0.049	0.042	0.6	Primary data

4.9.4 Sensitivity analysis

To deal with uncertainties in the study, two types of sensitivity analysis was done. First, one way sensitivity analysis was done using tornado diagram for the low and high values of variables from the base value. The choice of lower and higher values were made by consideration of whether they reflect clinical and economic feasibility of the range with respect to the setting. To account for error in number of health centers used for Facility based VCT, assumptions, and test kits quality; sensitivity analysis was conducted on costs, probabilities, sensitivity and specificity respectively (49). The lower and higher values of probabilities of being tested at a VCT site were varied by subtracting and adding 10,000 on the expected number of population to be served under that site (denominator). The cost were varied by reviewing cost of supply agencies from whom government health centers are allowed to buy and allowing variation of salary by looking at the least and highest salary of the health facilities. Considering this, a 20% variation from the mean cost were allowed for the costs of the three models. Sensitivity analysis is conducted on HIV prevalence taking into consideration that HIV prevalence is likely to change over time. It has been reported that as prevalence rises, the costs of testing increase, although economies of scale may be observed as well (24).

Second, probabilistic sensitivity analysis is conducted for distribution of selected variables. The probabilistic sensitivity analysis output considers combined uncertainty of a number of parameters to see what difference they create on the incremental cost-effectiveness ratio. PSA uses a distribution rather than a predetermined values for each parameters. Gamma and beta distribution were used for distribution of cost and probabilities respectively.

4.10 Data Quality Assurance and Management

To maintain the quality of the data, the data collection tools were adopted from costing guideline which was designed in consistent with objectives of this research. The principal investigator has submitted the draft of the tool to the advisor and colleagues for comment and the comments given were incorporated in to the final tool. Training was given to the supervisor and the data collectors to make sure the intended data is collected with quality. Furthermore, pretest was conducted on the tools to look for any editable content. The principal investigator has monitored the entire research process and check the quality of data to be collected during data collection process on daily basis for consistency and completeness.

4.11 Ethical Consideration

Ethical approval for the study was obtained from AAU school of public health ethical review committee. An official letter of approval was written to Addis Ababa city administration regional health bureau and selected VCT sites.

4.12 Result Dissemination

The findings of this research will be presented and submitted to the Addis Ababa University School of Public Health. Efforts will also be made to present it in seminars and workshops. It will also be given for peer reviewed journals for publication.

5. Results

5.1 Demographic Characteristics of Clients

The number of clients tested for HIV from July 2016 to June 2017 in the 10 Health centers, 1 Standalone and 15 Mobile sites are; 12,913, 3,155 and 128,199 respectively. The number of women tested for HIV are higher in the health centers (59%) and less in standalone clinic (47%) and mobile sites (34%) when compared to men. The percentage of women among the number of people who tested positive for HIV are 68% in Facility, 61% in Standalone and 58% in Mobile sites. This indicates higher positivity rate of women than men despite the less number of test for HIV in both Standalone and Mobile VCT sites.

Table 3: Clients who received VCT service in the study in 2009 EFY

	Facility (positive)	Standalone (positive)	Mobile (positive)
Sex			
Male (positive)	5,347 (134)	1,685 (54)	85,668 (1,389)
Female (positive)	7,566 (278)	1,470 (83)	42,214 (1,780)
Age			
15-19	1,897	430	10,267
20-24	3,734	655	40,398
25-49	6,468	1,921	72,524
>= 50	814	149	4,693
Total (positive)	12,913 (412)	3,155 (137)	128,199 (3169)

The mean number of clients tested for HIV are 1,291 in a Facility, 3,155 in a Standalone and 8,546 in Mobile based VCT. The mean number of HIV-seropositive individuals identified in the corresponding sites are 41, 137 and 211 respectively. Both the mean number of clients tested and mean HIV-seropositive individuals identified at a service site is higher in Mobile based VCT than the Standalone and Facility based VCT.

5.2 Cost of Capital and Recurrent Inputs

5.2.1 Cost per HIV-seropositive individual

The capital and recurrent inputs under Facility, Standalone and Mobile based VCT include: building, equipment, vehicle, supply, salary, and glove and test kits. The cost per HIV-seropositive individual identified and the cost per client tested is estimated for all the capital

and recurrent inputs. The cost per HIV-seropositive individual identified at Facility based VCT was USD 153.6. Out of this, cost of personnel salary accounts for 50.2% and cost of test kits and gloves accounts for and 30.4% of the total cost. The cost of building, other supplies and equipment account for 14.8%, 2% and 2.5% of the unit cost, respectively. Similarly, the cost per HIV-seropositive individual identified at Standalone based VCT was USD 154.1 and cost of personnel salary takes 54.5% and cost of test kits and gloves account for 22.4% of the cost. Building (17.7%), other supplies (2.4%) and equipment (2.7%) share little portion of the cost. The cost per HIV-seropositive individual identified at Mobile based VCT was USD 138.1. Higher percentage is attributed to cost of personnel salary (35.2%) and cost of test kits and gloves (50.7%). The cost of vehicle rent (9.4%), building (2%), other supplies (2.5%), and equipment (1%) are the remaining cost components.

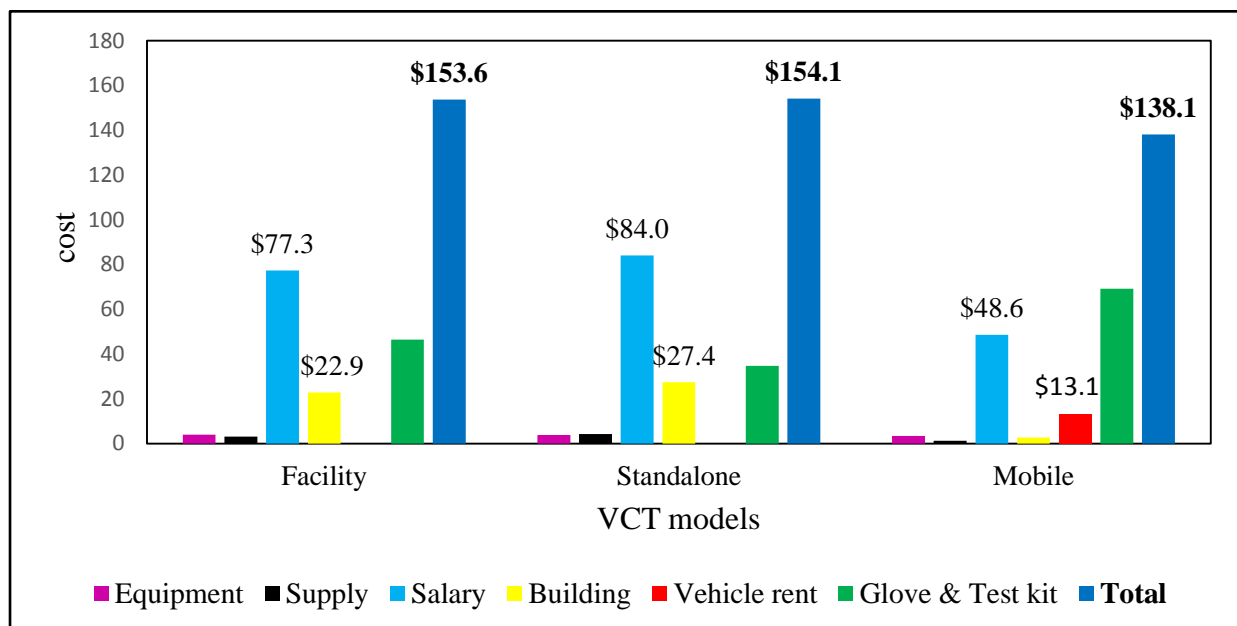


Figure 3: Mean cost per HIV-seropositive individual identified for capital and recurrent inputs

5.2.2 Cost per client tested

Similarly, the cost per client tested for HIV in Facility, Standalone and Mobile based VCT was estimated. The cost per client tested at Facility based VCT is USD 4.9. The cost of personnel salary (49%) and gloves and test kits (30%) take higher share. The cost of building, other supplies and equipment contribute to the rest of the cost. The cost per client tested at Standalone based VCT is USD 6.9. Higher percentage is attributed to the cost of personnel salary (54.4%), gloves and test kits (22.4%), and building (17.6%). Other supplies and equipment contribute to the remaining cost. The cost per client tested at Mobile based VCT is USD 3.4. Out of this cost; the cost of glove and test kit, personnel salary and vehicle rent

contribute for 59%, 35.3%, and 9% of the cost, respectively. Building, other supplies and equipment take small portion of the unit cost.

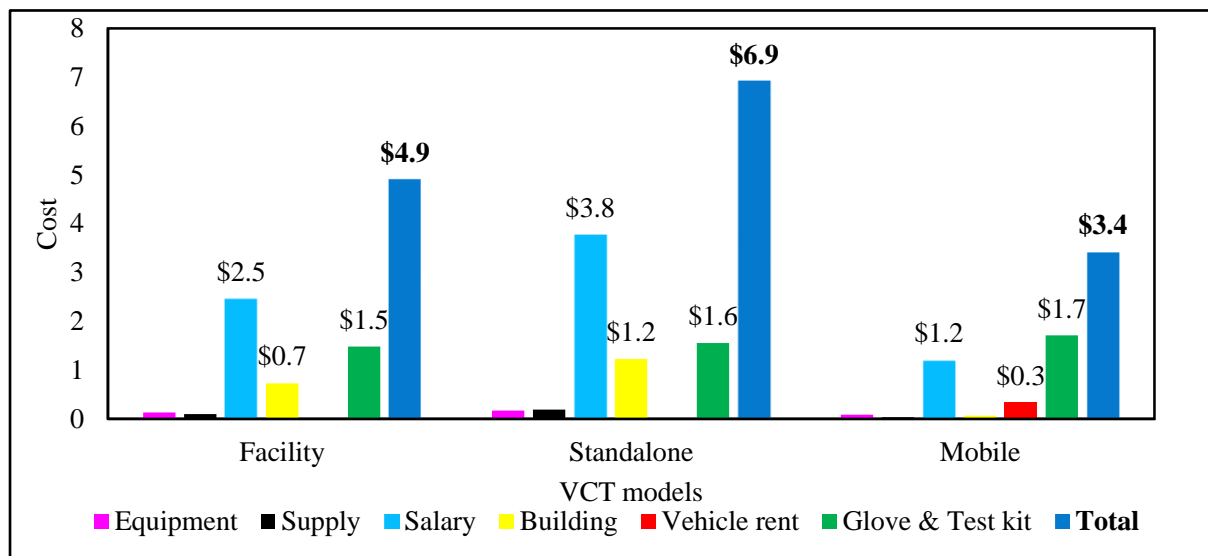


Figure 4: Mean cost per client test for capital and recurrent inputs

5.3 Cost of Support and Care (VCT) Center

5.3.1 Facility based VCT

The support service center under facility based VCT include: Medical director (head), data clerk, finance, human resources, cleaning, security and disease prevention. The average cost of providing VCT service at a Facility based VCT is USD 6,329.6. Out of this cost; the cost of care center (VCT center) for a single health center is USD 5,366 which is 85% of the total cost of providing VCT service at a health center. Support service centers contribute to 15% of the cost.

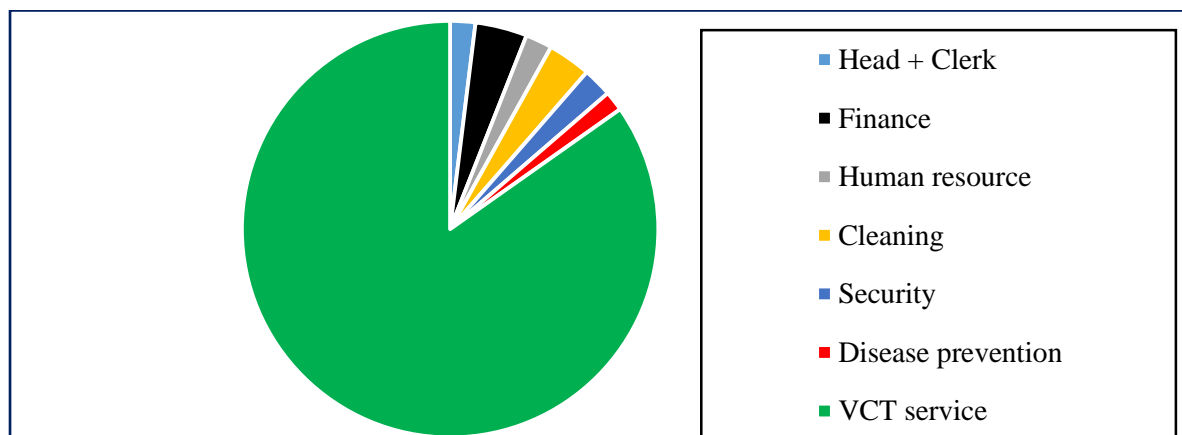


Figure 5: Cost of support and care center in Facility based VCT; Head + Clerk= Medical Director and data clerk

5.3.2 Standalone based VCT

The support centers under Standalone based VCT are: country program director, medical director, prevention officer, finance, accountant, data clerk, site driver, and counsellor coordinators. The total cost of providing VCT service at Standalone site is USD 21,117.3. Out of this; the cost of VCT center in a single standalone VCT site is USD 16,292 which contribute to 77% of the total cost, and support service centers contribute to 23% of the cost.

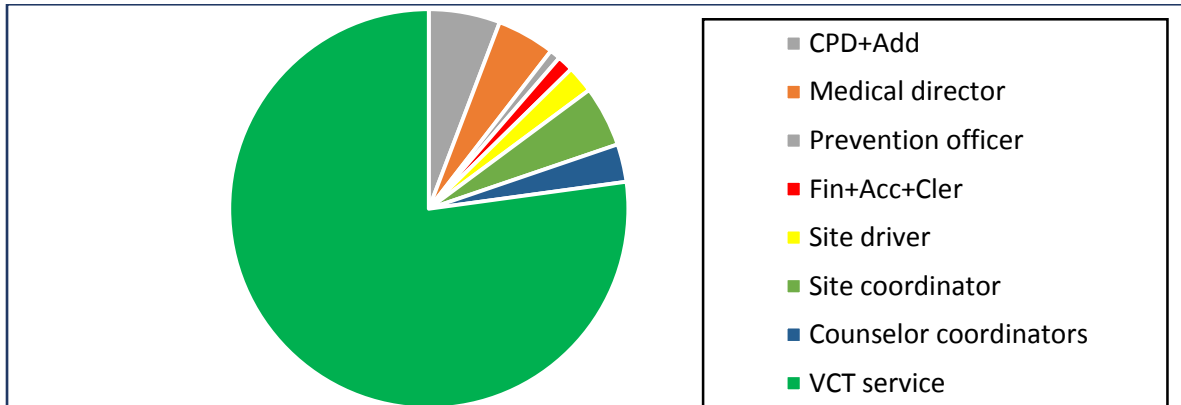


Figure 6: Cost of support and care center in standalone based VCT; CPD+Add= Country program director and Site administrator, Fin+Acc+Cler= Finance, Accountant and Data clerk

5.3.3 Mobile based VCT

The support centers under Mobile based VCT include: country program director, site administration, prevention officer, finance, accountant, data clerk, vehicle rent, site driver, and outreach coordinators. The total cost of providing VCT at a single mobile site is USD 29,182. Out of this, the cost of direct VCT center for a single mobile site is USD 23,168.8 which is 75% of the total cost and support service centers contribute to 25% of the cost.

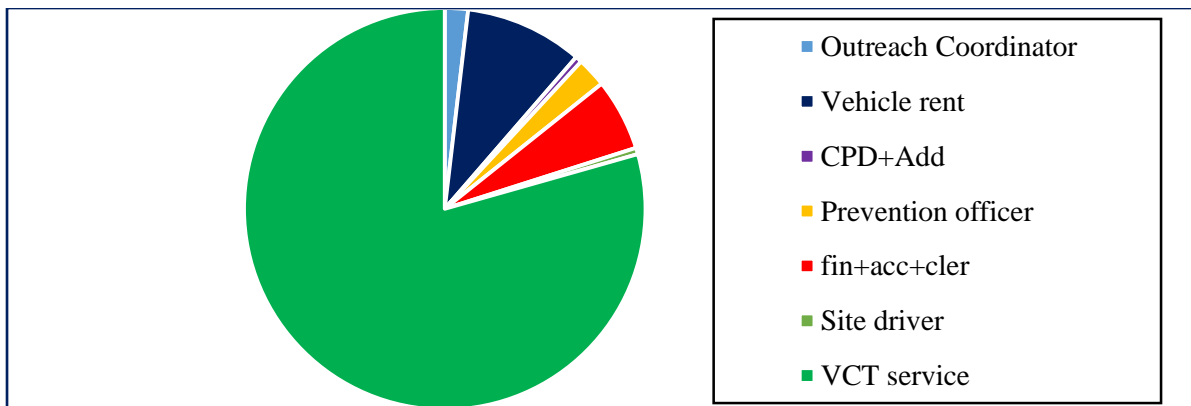


Figure 7: Cost of support and care center in Mobile based VCT; CPD+ Add=country program director and site administrator; fin+acc+cler=finance, accountant and data clerk

5.4 The Total and Unit Cost of the VCT Models

The contribution of cost from support service center and cost from direct service center to a single site for the three VCT model is shown in the table below. The cost of support service center is higher for Mobile based VCT followed by the cost of standalone and facility based VCT.

Table 4: Total and mean cost of testing clients and identifying HIV-seropositive individual

Service site	Support center	VCT center	Total cost	Tested clients	cost per Test	HIV-seropositive individuals	cost per HIV-seropositive
Facility	963.6	5,366	6,329.6	1,291	4.9	41.2	153.6
Standalone	4,822.1	16,295.2	21,117.3	3,155	6.6	137	154.1
Mobile	6,013.3	23,168.7	29,182	8,546	3.4	211.26	138.1

5.5 Cost-Effectiveness analysis of the VCT Models

5.5.1 Cost-effectiveness outputs

To determine the most cost-effective VCT model, the expected cost and effectiveness was calculated and graphed on cost-effectiveness plane. The expected cost is graphed on the Y-axis and the expected effectiveness associated with the cost of each VCT model is graphed on the X-axis (figure 8) for the three interventions. The graph connects strategies which are not dominated (Facility and Mobile based VCT) by a line segment which will form cost-effectiveness frontier. Only the strategies which are on this frontier are optimal choice. Then the choice of optimal strategy among the points on the cost-effectiveness frontier is made by calculating Incremental cost-effectiveness ratio (ICER) for the two undominated strategies; Facility and Mobile based VCT.

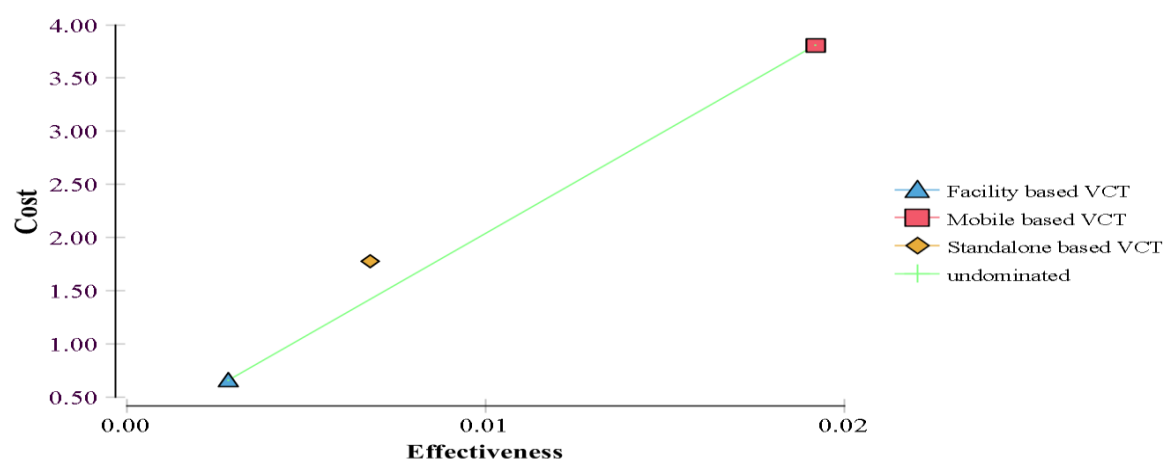


Figure 8: Baseline cost-effectiveness plane

When implementing the ICER, strategies are listed from lesser cost to the higher cost. Then incremental values are calculated as compared to the previous less costly strategy. Standalone based VCT is extendedly dominated by Mobile and Facility based VCT since the ICER of Standalone based VCT compared to Facility based VCT is higher than the next effective (Mobile based VCT) strategy.

Table 5: Baseline cost-effectiveness results

Strategy	Cost	Incr. Cost	Effect	Incr. Effect	ICER
<u>Excluding dominated</u>					
Facility based VCT	0.66		0.0028		
Mobile based VCT	3.80	3.14	0.02	0.016	192.1
<u>All</u>					
Facility based VCT	0.66		0.003		
Standalone based VCT	1.78	1.12	0.007	0.004	283.4
Mobile based VCT	3.80	2.02	0.02	0.012	163.0

After excluding the extendedly dominated Standalone based VCT, the ICER of Facility and Mobile based VCT is compared again by sorting from the lower to the higher cost. The incremental cost-effectiveness ratio of the Mobile based VCT is USD 192.1 for identification of additional HIV-seropositive individual when compared to Facility based VCT.

5.5.2 Sensitivity analysis

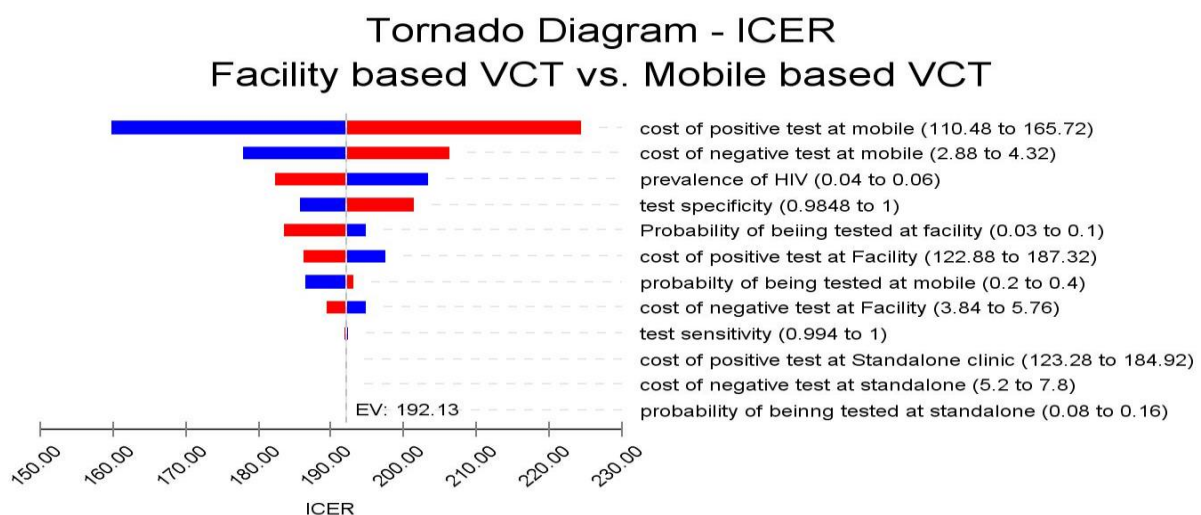
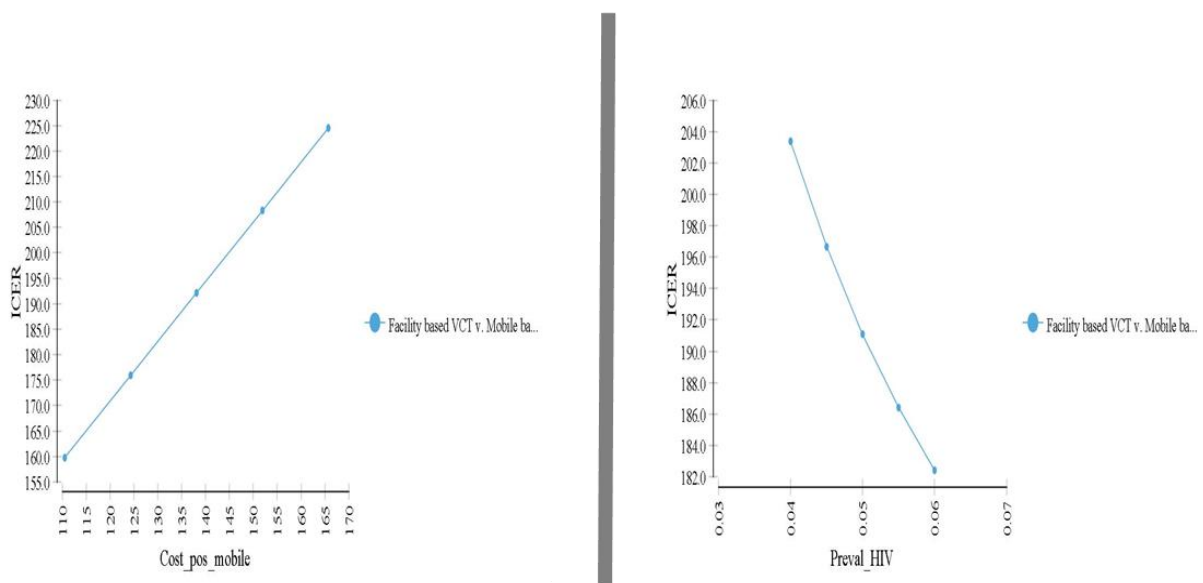


Figure 9: One way sensitivity analysis using tornado diagram

From result of tornado diagram above, the red color on the right indicate that the parameter have a direct relation with the ICER and the blue color on the right shows the parameter have an indirect relation with the ICER. The cost of positive test at Mobile based VCT has highest impact on the incremental cost-effectiveness ratio. Although the ICER is changing for lower and higher values of cost of positive test at Mobile based VCT, the ICER is around 17% change (USD 158 to 225 per HIV-seropositive individual identified) from the base ICER value. The ICER is less sensitive to lower and higher values of other variables in the tornado diagram. As the cost of identifying HIV-seropositive individuals increase at Mobile based VCT, the Incremental cost-effectiveness ratio also increases and Vis versa. On the other side, as the HIV prevalence increases, the incremental cost-effectiveness ratio get reduced at Mobile based VCT (figure 10). This also indicate although the total cost of testing for HIV increase as the prevalence rise, the unit cost of testing will decrease due to the higher number of the HIV positive individuals to be identified by Mobile based VCT.



Cost_pos_mobile = Cost of positive at mobile VCT;

Preval_HIV= Prevalence of HIV

Figure 10: One way sensitivity analysis of selected parameters

A thousand iteration of PSA was done on: costs, probabilities of being tested for the three model, prevalence, sensitivity and specificity. The average result of probabilistic sensitivity analysis for the thousand iteration is similar to the base value of the three models.

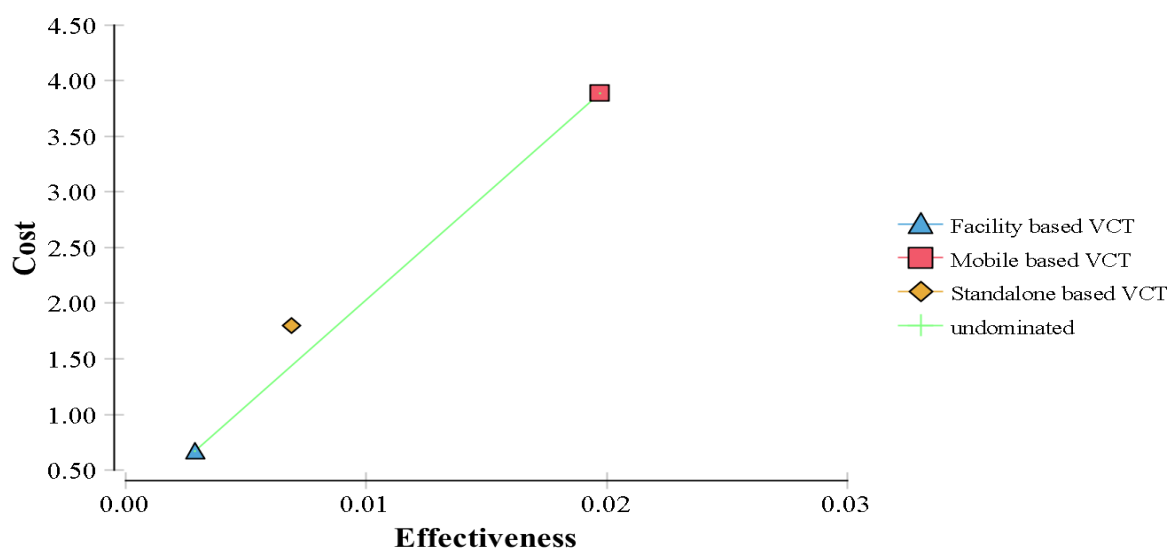


Figure 11: Probabilistic sensitivity analysis: cost effectiveness analysis plane

The ICER of Standalone based VCT which is again extendedly dominated under PSA is USD 287 per HIV-seropositive individual identified. It is close to the base value of USD 283; a 1% increase. Similarly after removing the extendedly dominated strategy, the ICER of Mobile based VCT rise from USD 192 to 194 which is again a small change, a 1% increase. The average cost-effectiveness ratio for the three strategies have increased only by 1%. There is 99% probability for the ICER of Mobile based VCT to be around the base value for the changing distribution of the selected parameters.

Table 6: probabilistic sensitivity analysis: cost-effectiveness results

Strategy	Cost	Incr. cost	Effectiveness	Incr. effectiveness	ICER
<u>Excluding dominated</u>					
Facility based VCT	0.67		0.0028		
Mobile based VCT	3.07	2.4	0.015	0.0123	194.6
<u>All</u>					
Facility based VCT	0.67		0.003		
Standalone based VCT	1.68	1.01	0.006	0.0035	287.5
Mobile based VCT	3.07	1.4	0.015	0.0088	157.7

5.5.3 Incremental net monetary benefit

The probabilistic sensitivity analysis will allow us to use range of values of cost-effectiveness threshold value (willingness to pay) over which a given strategy may be chosen over the

other. The incremental net monetary benefit (INMB) is used as a sensitivity analysis tool on the willingness to pay and it is calculated by multiplying the difference in effectiveness by WTP and subtract the difference in cost of the two intervention as shown in the equation below (C=Cost, E=Effectiveness, M=Mobile, and F= Facility).

$$INMB(M - F) = E(M - F) * WTP - C(M - F)$$

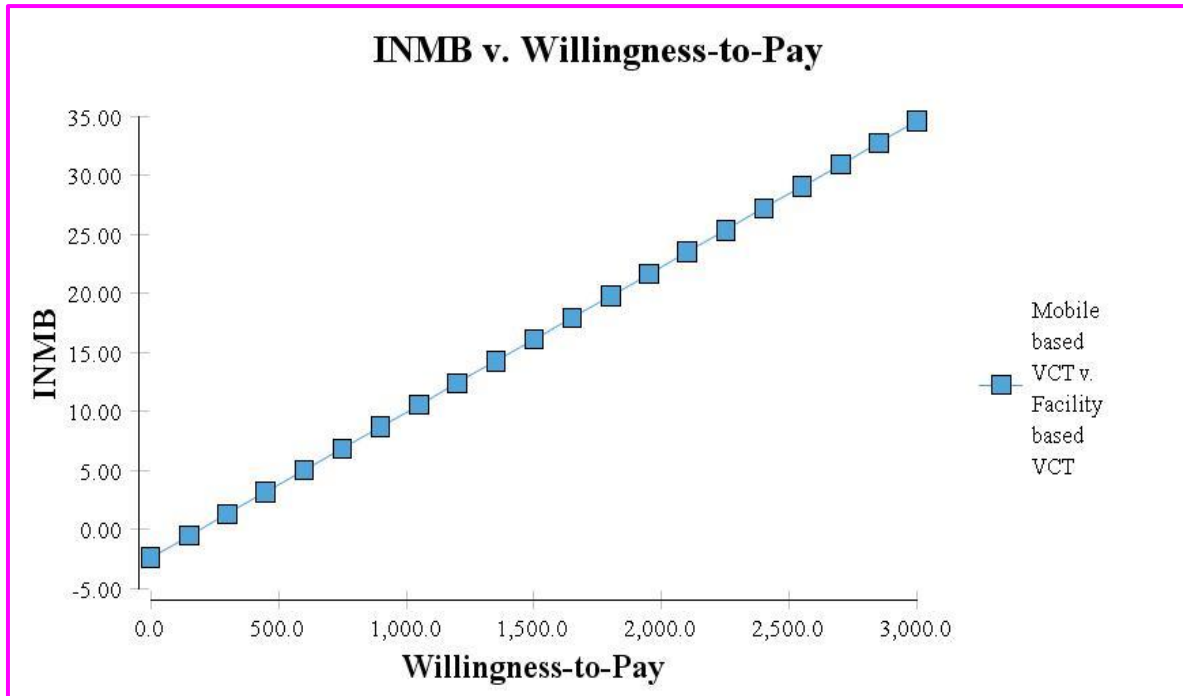


Figure 12: PSA: INMB verses WTP for Mobile and Facility based VCT

Assuming the decision maker is willing to allocate additional resources to identify more HIV-seropositive individuals to reach the 90-90-90 goal, incremental net monetary benefit is calculated as a guide to what willingness to pay threshold will allow us to get one more HIV positive client. The incremental net monetary benefit for the Mobile based VCT is positive above the point USD 194 on the willingness to pay. The positive INMB shows at cost-effectiveness threshold (willingness to pay) above USD 194, Mobile based VCT is cost-effective in identifying more HIV positive individuals.

6. Discussions

6.1 Cost of the VCT Models

The cost per client tested for HIV at the Facility based VCT is USD 4.9 (1,291 clients tested). The cost drivers were personnel salary (49%) and cost of glove and test kit (30%). This indicates, since the cost of personnel salary is constant throughout the year (fixed cost), the unit cost of providing VCT service could be less than USD 4.9 if more people were tested for HIV as the cost of personnel salary is distributed among the clients. This finding of cost per client test for HIV at health center is close to studies; in Malawi (USD 5), in Zambia (USD 4.2) and in Zimbabwe (USD 8.8) (32). Another study in Malawi indicated unit cost of facility based VCT to be ranging from USD 7.5 to 10.5 (34).

The cost per client tested for HIV at the Standalone based VCT is USD 6.6 (3,155 clients tested). Although the number of clients tested are higher than the Facility based VCT, the unit cost is higher due to the way the project cost is implemented. The cost drivers were personnel salary (55%), building (17%) and glove and test kits (22.4%). This indicates, over 70% of the total cost is fixed cost. Similar to the facility based VCT, if more people were tested throughout the year, the fixed cost could be distributed among the clients tested and the unit cost could be less than USD 6.6. The cost per client test for standalone based VCT in this study vary dramatically from studies in other countries. Study in South Africa (37), Uganda (35) Vietnam (36), Namibia (39), showed the cost of standalone VCT to be USD 51, 19 and 58, and 60 per client tested respectively. Systematic review of low and middle income countries also estimated the cost of standalone VCT to be USD 20 (22).

The cost per clients tested for HIV at Mobile based VCT is USD 3.7 (8,645 clients tested). The cost driver is the variable cost of glove and test kit (59%) followed by personnel salary (35%). This indicates, despite the higher total cost of providing the service at mobile site, higher number of individuals are tested which decreases the cost per client tested for HIV to be USD 3.8. This cost also vary from costing studies conducted in another countries. Study in South Africa (37), Kenya (38) and Namibia (39) estimated the cost per client test for HIV to be USD 25, 15, and 60 respectively. A systematic review conducted also estimated the cost per client test for HIV in low and middle income countries to be USD 60 (22).

The cost per HIV-seropositive individual identified at Facility, Standalone and Mobile based VCT vary between different studies. The cost per HIV sero-positive client for Facility based

VCT was USD 153.6. Systematic review for low and middle income countries estimated the facility cost of HIV-seropositive individual to be USD 60 (22). The corresponding cost in Malawi, Zambia, and Zimbabwe was USD 79, 73 and 178 respectively (32). Other studies estimated the cost to be USD 43 in Uganda (35), USD 252 in Vietnam (36), and USD 557 in Namibia (39). The cost of HIV-seropositive individual at Standalone based VCT in this study was USD 154. The cost were USD189 in Kenya (38) and USD 186 in Vietnam (36). The cost of HIV-seropositive individual at Mobile based VCT in this study was USD 138. Systematic review estimated the cost to be USD 212 (22). The cost per HIV-seropositive individual was; USD 157 in Kenya (38), and 578 in Namibia (39).

The difference in the variation of the unit cost of the three models from other studies are attributed to costing method, the resources included under the study, the difference in use of type of resource, prevalence of the disease (22), difference in structural implementation of projects, economy of the country, and the level of encouragement of the population to test for HIV which determines the level of economies of scale (23, 24).

6.2 Cost-Effectiveness Analysis

This cost-effectiveness study uses decision tree model to compare the cost-effectiveness of Facility, Standalone and Mobile based VCT strategies in Addis Ababa. Among the three models, Standalone VCT is extendedly dominated by the Facility and Mobile based VCT. The incremental cost of Mobile based VCT to identify one more HIV-seropositive client was USD 192. This study found that more HIV positive clients would know their HIV status by testing through Mobile based VCT if more resource is allocated to implement it. Key population accounts for new HIV infection in 80% of low prevalent settings and 25% of sub Saharan Africa by 2015. Although the disease prevalence is decreasing nationally, the prevalence in Addis Ababa is 4.9% and focusing only on key population in highly prevalent setting such as Addis Ababa and other urban population may slower the possibility of achieving higher success in the prevention of HIV (25). Due to the higher HIV prevalence in Addis Ababa and the Mobile based VCT services being suited to highly populated areas, providing VCT through mobile service would decrease the number of HIV-seropositive individuals who do not know their status and also decrease the number of new HIV infection. This will help to achieve the first target, 90% of infected individuals to know their status and start early ART treatment for better health and reduce transmission thereby to foster the move

in eliminating the HIV epidemic and improvement of the societal economy as set by the UNAIDS (4).

Although there is no model based study which compares the three models together, Studies conducted in South Africa and Kenya recommended the addition of Mobile based VCT on Facility based VCT (38, 57). The 90-90-90 goal demands additional USD 6 billion dollar and 30% of HIV/AIDS resource to be allocated to HIV prevention programmes. As knowledge of HIV status is the first step in the 90-90-90 cascade, efforts to enroll people living with HIV into care and to initiate and sustain treatment are affected when less people know their HIV status. Only 67% of people living with HIV in Ethiopia know their status which will reduce both the number of people on ART and viral suppressed individuals. Mobile based VCT is effective in identifying more HIV-seropositive individuals early in their disease progression and have high impact in reducing transmission due to early ART initiation than the Facility based VCT. increase in domestic and donor investment to use the Mobile based VCT in addition to other HIV prevention interventions will improve the progress to the goal (9, 26).

The ICER of Mobile based VCT remain stable in all sensitivity analysis for the selected parameters. The ICER was similar to the base value for lower and higher values and the changing distributions. The one way sensitivity analysis indicated that as the prevalence of HIV increases, Mobile based VCT will give more value to money. Since the prevalence of HIV is increasing each year in Addis Ababa and become the most prevalent area in 2017, focusing on the diagnosis of the HIV-seropositive individuals by testing through Mobile based VCT is a big opportunity as the city is suited for mobile testing due to its dense population. From the probabilistic sensitivity analysis output, the incremental net monetary benefit of providing Mobile based VCT over the Facility based VCT increase linearly as the cost-effectiveness threshold value (willingness to pay) rises above USD 194. This indicates, as the willingness to pay for the Mobile based VCT increase, the incremental net monetary benefit of the society will continually rise.

7. Conclusion and Recommendation

7.1 Conclusion

The research intended to answer the following question. First; the cost of Facility, Standalone and Mobile based VCT was described, cost contribution of support centers to the total cost of a VCT site for the VCT models and the unit cost of capital and recurrent inputs of each VCT models and the cost drivers were broadly described. Second; the cost-effectiveness of Facility, Standalone and Mobile based VCT were compared using decision tree modeling.

The total cost of providing VCT at a single mobile site is higher than that of the standalone and facility sites. The cost per tested and per HIV-seropositive individual identified was less for mobile based VCT than the standalone and facility based VCT. Unlike standalone and facility based VCT, the fixed cost was less and the variable cost was high for Mobile based VCT. This shows higher number of individuals are tested and the fixed costs are distributed over the clients.

Comparing the cost-effectiveness of the models, Standalone based VCT is extendedly dominated by Facility and Mobile based VCT. Mobile based VCT is very cost effective if the decision maker is willing to pay USD 192 for every HIV-seropositive individual identified.

HIV is one of the most devastating epidemic over the recent years. To prevent this epidemic UNAIDS has set goal to diagnose 90% of people living with HIV AIDS. Mobile based VCT is effective to identify more people living with the HIV in Addis Ababa and other urban settings.

Hence; due to the higher prevalence of HIV in Addis Ababa and the Mobile based VCT being very effective in identifying more HIV-seropositive individuals, this study will help policy makers and NGOs working on HIV control program to shape their direction of intervention and allocate more resource to Mobile based VCT to achieve the 90-90-90 goals.

7.2 Recommendation

Mobile based VCT should be used as one of the major services to reach the 2020 goals as only one NGO; AHF Ethiopia, is performing this testing service in Addis Ababa. HAPCO should consider implementing mobile testing in urban areas to achieve the 2020 goal. PEPFAR, AHF, Pro-Pride should broaden their service by considering the use of Mobile based VCT. Regional health bureau of urban areas should consider broadening the use of mobile based VCT as part of their HIV control program.

8. Limitations and Strengths of the Study

8.1 Limitations of the Study

- The use of intermediate outcome might pose difficulty in comparing with other interventions which are not reported with the same outcome measure.
- Only 10 health centers, one from each city administration was used for comparison considering the resource available.
- Since Mobile based VCT only performed in the year 2009 (EFY), only a one year data on clients were used for the three models.

8.2 Strengths of the Study

- The use of ingredient costing method which will allow analysts from other country to easily assess if costs collected can be used or modified to their settings.
- The use of reciprocal cost allocation to allocate the cost among the support service centers before allocating to VCT center to give accurate estimate of the site service costs.
- This study has also clearly mentioned the cost contribution of support centers to the VCT service center.
- The use of probabilistic sensitivity analysis to account for uncertainty.

9. References

1. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011;365(6):493-505.
2. UNAIDS. The Gap report. 2015. Available from: http://www.unaids.org/sites/default/files/media_asset/UNAIDS_Gap_report_en.pdf accessed on 04/02/2017.
3. UNAIDS. Global AIDS update.2016 available from: http://www.unaids.org/sites/default/files/media_asset/global-AIDS-update-2016_en.pdf accessed on 05/04/2017.
4. Diagnostic access initiative to achieve the 90-90-90 treatment target. Available from: http://www.unaids.org/en/resources/documents/2015/20150422diagnostics_access_initiative.
5. Kurth AE, Lally, Michelle A. Choko, Augustine T. Inwani, Irene W. Fortenberry, J. Dennis. HIV testing and linkage to services for youth. *J Int AIDS Soc*. 2015;18:19.
6. FMOH. Guidelines for HIV Counselling and Testing in Ethiopia. 2007. Available from: http://www.who.int/hiv/topics/vct/ETH_HCT_guidelinesJune26_clean.pdf.
7. World Health Organization. Service delivery approaches to HIV testing and counselling (HTC) : a strategic HTC programme framework Geneva, Switzerland2012. Available from: http://apps.who.int/iris/bitstream/10665/75206/1/9789241593877_eng.pdf.
8. Wachira JK, S. Ndege, S. Mamlin, J. Braitstein, P. What is the impact of home-based HIV counseling and testing on the clinical status of newly enrolled adults in a large HIV care program in Western Kenya? *Clin Infect Dis*. 2012;54(2):275-81.
9. Leisegang R, Cleary S, Hislop M, Davidse A, Regensberg L, Little F, et al. Early and late direct costs in a Southern African antiretroviral treatment programme: a retrospective cohort analysis. *PLoS Med*. 2009;6(12).
10. Maheswaran HP, Stavros MacPherson, Peter Choko, Augustine T. Kumwenda, Felistas Lalloo, David G. Clarke, Aileen Corbett, Elizabeth L. Cost and quality of life analysis of HIV self-testing and facility-based HIV testing and counselling in Blantyre, Malawi. *BMC Medicine*. 2016;14:34.
11. Sharma M, Ying R, Tarr G, Barnabas R. Systematic review and meta-analysis of community and facility-based HIV testing to address linkage to care gaps in sub-Saharan Africa. *Nature*. 2015;528(7580):77-85

12. Tanser F, Barnighausen T, Grapsa E, Zaidi J, Newell ML. High coverage of ART associated with decline in risk of HIV acquisition in rural KwaZulu-Natal, South Africa. *Science*. 2013;339(6122):966-71.
13. Staveteig S, Wang S, Head SK, Bradley SEK, Nybro E. Demographic patterns of HIV testing uptake in Sub-Saharan Africa. 2013.
14. Haniko N. Joint Review Meeting of the EFY 2009 Nine Months performance of National HIV AIDS Multi-sectoral Response. 2017.
15. Ethiopia demographic and health surveys key indicators. central statistical agency, 2016.
16. Ethiopian demographic and health survey. Central Statistical Agency, 2017.
17. Kirakoya S, Jean. F, Maheu. K, Giroux M. Uptake of HIV testing in Burkina Faso: an assessment of individual and community-level determinants. *BMC Public Health*. 2017;17:486.
18. van Rooyen H, McGrath N, Chirowodza A, Joseph P, Fiamma A, Gray G, et al. Mobile VCT: Reaching men and young people in urban and rural South African pilot studies. *AIDS Behav*. 2013;17(9).
19. van Schaik N, Kranzer K, Wood R, Bekker LG. Earlier HIV diagnosis--are mobile services the answer? *S Afr Med J*. 2010;100(10):671-4.
20. Morin SF, Khumalo-Sakutukwa G, Charlebois ED, Routh J, Fritz K, Lane T, et al. Removing barriers to knowing HIV status: same-day mobile HIV testing in Zimbabwe. *J Acquir Immune Defic Syndr*. 2006;41(2):218-24.
21. MacPherson P, Corbett EL, Makombe SD, van Oosterhout JJ, Manda E, Choko AT, et al. Determinants and consequences of failure of linkage to antiretroviral therapy at primary care level in Blantyre, Malawi: a prospective cohort study. *PLoS One*. 2012;7(9):e44794.
22. Johnson C, Dalal S, Baggaley R, Hogan D, Parrott G, Mathews R, et al. Systematic review of HIV testing costs in high and low income settings. NCBI. 2015.
23. Smith JA, Sharma M, Levin C, Baeten JM, van Rooyen H, Celum C, et al. Cost-effectiveness of community-based strategies to strengthen the continuum of HIV care in rural South Africa: a health economic modelling analysis. *The Lancet HIV*. 2015;2(4):159-68.
24. UNAIDS. Costing Guidelines for HIV Prevention Strategies. genova, switzerland. 2000.
25. Johnson LF, Dorrington RE, Moolla H. Progress towards the 2020 targets for HIV diagnosis and antiretroviral treatment in South Africa. *South Afr J HIV Med*. 2017;18(1).

26. UNAIDS. Ending AIDS progress towards 90–90–90 targets: UNAIDS; 2017. Available from: http://www.unaids.org/en/resources/documents/2017/20170720_Global_AIDS_update_2017.
27. Levi J, Raymond A, Pozniak A, Vernazza P, Kohler P, Hill A. Can the UNAIDS 90-90-90 target be achieved? A systematic analysis of national HIV treatment cascades. *BMJ Global Health*. 2016;1(2).
28. Porter K, Gourlay A, Attawell K, Hales D, Supervie V, Touloumi G, et al. Substantial Heterogeneity in Progress Toward Reaching the 90-90-90 HIV Target in the WHO European Region. *JAIDS* 2018;79(1):28-37.
29. PEPFAR. 2018 annual report to congress 2018. Available from: <https://www.pepfar.gov/press/2018annualreport/index.htm>.
30. Interests Committee on Envisioning a Strategy for the Long-Term Burden of HIV/AIDS. Preparing for the Future of HIV/AIDS in Africa a Shared Responsibility. Washington: National Academies Press; 2010.
31. Gray LD. The U.S. President's Emergency Plan for AIDS Relief (PEPFAR) : a comparative analysis of USA presidents' policy towards Africa. *African Renaissance*. 2017;14(1-2):17-37.
32. Mwenge L, Sande L, Mangenah C, Ahmed N, Kanema S, d'Elbee M, et al. Costs of facility-based HIV testing in Malawi, Zambia and Zimbabwe. *PLoS One*. 2017;12(10):e0185740.
33. Forsythe S, Arthur G, Ngatia G, Mutemi R, Odhiambo J, Gilks C. Assessing the cost and willingness to pay for voluntary HIV counselling and testing in Kenya. *Health Policy Plan*. 2002;17(2):187-95.
34. Maheswaran H, Petrou S, MacPherson P, Choko AT, Kumwenda F, Lalloo DG, et al. Cost and quality of life analysis of HIV self-testing and facility-based HIV testing and counselling in Blantyre, Malawi. *BMC Med*. 2016;14:34.
35. Menzies NA, B.Wanyenze, R.Nuwaha, F.Mugisha, B.Coutinho, A.Bunnell, R.Mermin, J.Blandford, J. M. The costs and effectiveness of four HIV counseling and testing strategies in Uganda. *AIDS*. 2009;23(3):395-401.
36. Nguyen VT, Nguyen HT, Nguyen QC, Duong PT, West G. Expenditure Analysis of HIV Testing and Counseling Services Using the Cascade Framework in Vietnam. *PLoS One*. 2015;10(5):e0126659.
37. Meehan S, Naidoo P, Claassens MM, Lombard C, Beyers N. Cost analysis of two community-based HIV testing service modalities led by a Non-Governmental Organization in Cape Town, South Africa. *BMC Health Serv Res*. 2017;17(1):801.

38. Grabbe KL, Menzies N, Taegtmeier M, Emukule G, Angala P, Mwega I. Increasing access to HIV counseling and testing through mobile services in Kenya: strategies, utilization, and cost-effectiveness. *J Acquir Immune Defic Syndr*. 2010;54(3):317-23.
39. de Beer I, Chani K, Feeley FG, Rinke de Wit TF, Sweeney-Bindels E, Mulongeni P. Assessing the costs of mobile voluntary counseling and testing at the work place versus facility based voluntary counseling and testing in Namibia. *Rural Remote Health*. 2015;15(4):3357.
40. Sharma M, Ying R, Tarr G, Barnabas R. Systematic review and meta-analysis of community and facility-based HIV testing to address linkage to care gaps in sub-Saharan Africa. 2015;528:77-85.
41. world population review. Ethiopia population. 2018. Available from: <http://worldpopulationreview.com/countries/ethiopia/>.
42. Gray AM, Clarke PM, Wolstenholme JL, Wordsworth S. *Handbooks in Health Economic Evaluation Series -Applied Methods of Cost-effectiveness Analysis in Healthcare*. 2010.
43. World Health Organization. Consolidated guidelines on HIV testing services : 5Cs: consent, confidentiality, counselling, correct results, and connection 2015. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK316021/>.
44. Creese A, Parker D. *Cost analysis in primary health care : a training manual for programme managers*. [Geneva]: [WHO]; 1999.
45. Olson S, Bogard K. *Considerations in applying benefit-cost analysis : to preventive interventions for children, youth, and families : workshop summary*. 2014.
46. edejer TT-T, Baltussen R, Adam T, Hutubessy R, Acharya A, Evans DB, et al. *WHO guide to Cost-effectiveness analysis*. geneva: WHO; 2003.
47. Johns BB, Rob Hutubessy, Raymond. Programme costs in the economic evaluation of health interventions. *Cost Effectiveness and Resource Allocation*. 2003;1(1):1.
48. Ulla S. *An Evaluation of Selected Literature on the Measurement of Costs in Health Economic Evaluations*. 2003.
49. Creese A, Parker D. *Cost Analysis in Primary Health Care: A Training Manual for Programme Managers*. Geneva, World Health Organization 1994.
50. Margaret P, Maggie Huff R. *A Step-by-step Methodological Guide for Costing HIV/AIDS Activities: partner for health reform*; 2001.
51. UNAIDS. *Costing guidelines for HIV/AIDS intervention strategies*. Asian development bank. 2004.

52. Phillips MA, Huff-Rousselle M, Partners for Health R. A step-by-step methodological guide for costing HIV/AIDS activities : resources and tools. Bethesda, Md.: Partners for Health Reformplus, Abt Associates; 2001.
53. Olson S, Bogard K. Considerations in Applying Benefit-Cost Analysis to Preventive Interventions for Children, Youth, and Families: Workshop. 2014.
54. Gray A, Clarke PM, Wolstenholme JL, Wordsworth S. Applied methods of cost-effectiveness analysis in health care Oxford: Oxford University Press; 2011. Available from: <http://public.eblib.com/choice/publicfullrecord.aspx?p=975569>.
55. United States Central Intelligence Agency. The CIA world factbook 2017. Available from: <https://www.overdrive.com/search?q=628D9AB0-5949-4A92-AAAC-1EE7E5842973>.
56. Trinity Biotech 2017. Available from: <https://www.fishersci.com/shop/products/trinity-biotech-uni-gold-recombigen-hiv-1-2-2/p-2897450>.
57. Bassett IV, Govindasamy D, Erlwanger AS, Hyle EP, Kranzer K, Van Schaik N. Mobile HIV screening in cape town, South Africa: clinical impact, cost and cost-effectiveness. PLoS One. 2014;9.

10. Annexes

Chosen base year _____

Service site name _____

Service center name _____

Annex 1: Recurrent and Capital Cost of Service Center

Section 1: Personnel

No	Name or ID number of staff member	Grade of staff member	Proportion of time at service center	Monthly cost of staff member	Annual cost of staff member	Annual cost to services center
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

Section 2: Building

No.	Buildings (room)	Annual rent/ hire	Furnishing (10%)	Total cost	% allocation	Annual cost
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

Section 3: Equipment

No.	Name of item	Item specification	Year bought	Useful life (years)	Purchase cost	Annualization factor	Annual cost to service center
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

Section 4: Supplies

No	Name of Item	Item specification	Number of consumed in period	Number of consumed/year	Cost/Item	Annual cost
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

Section 5: Other Recurrent Inputs

No.	Input name	Description	No. consumed per year	Cost per item	Annual cost
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Annex 2: Number of Clients and Time Taken for Testing

Section 1: HMIS Report on Voluntary Counseling and Testing Service of 2009

Age	Number of tested			Number of positive		
	Male	Female	Total	Male	Female	Total
15-19						
20-24						
25-49						
>50						
Total						

Section 2: VCT room; time for HIV testing

- Time spent during pre-counseling in minutes for a client

- Time spent during testing for a client

- Time spent during post-counseling for one HIV negative client

- Time spent during post-counseling for one HIV positive client

Annex 3: Total Cost of Service Center

No.	Description	Annual cost at service center
1	Personnel	
2	Building	
3	Equipment	
4	Supplies	
5	Other recurrent	
6	Total cost of service center	

Annex 4: The Cost Allocation among Support Service Centers in percentage

		Cost to					
		support center 1	support center 2	support center 3	support center 4	Support center 5	
Cost from	support center 1	Allocation base					
		% allocated	x				
	support center 2	Allocation base					
		% allocated		x			
	support center 3	Allocation base					
		% allocated			x		
	support center 4	Allocation base					
		% allocated				x	
	support center 5	Allocation base					
		% allocated					x
		total	total	total	total	total	

Annex 5: Contribution to VCT center from Support Service Centers

	Total support center 1	Total support center 2	Total support center 3	Total support center 4	Total support center 5
cost					
Allocation base					
allocation unit in VCT					
all units					
% contribution to VCT					
cost contributed VCT					

Annex 6: The Total Cost of VCT center

Cost of support service center to VCT service	
cost of care (VCT) center	
Total cost	

Declaration

I the undersigned, declare that this thesis is my original work, prepared under the guidance of Mr. Alemayehu Desalegne (PHD Fellow). All the resources and materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or fully to any other higher learning institution for the purpose of earning any degree.

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This thesis work has been submitted for examination with my approval as University primary advisor.

Name: Alemayehu Dessalegn Hailu (PHD fellow)

Signature: _____

Date: _____