Leveraging unemployed youth to strengthen HIV service delivery: an evaluation of a youth internship program at health facilities in South Africa

Deanna K. Tollefson

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Reading Committee:

Ann Duerr, Chair

Salome Charalambous

Gabrielle O'Malley

Carol Levin

Program Authorized to Offer Degree:

Department of Global Health

University of Washington

Abstract

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Deanna K. Tollefson

Chair of the Supervisory Committee:
Ann Duerr, Affiliate Professor
Departments of Epidemiology and Global Health

Background: Since 2018, Youth Health Africa (YHA) has placed more than 3,000 unemployed young adults in one-year internships at health facilities in South Africa to support HIV services as temporary lay health workers. While YHA is primarily designed to improve employment prospects for youth, it also hopes to strengthen the health system. This research assesses the impact (Aim 1), acceptability and appropriateness (Aim 2), and cost (Aim 3) of the YHA approach to strengthen the delivery of HIV services in South Africa.

Aim 1: We conducted two studies for this aim to explore the impact of YHA interns on HIV testing, treatment initiation, and retention in care, as measured by routinely collected data. The first study was a retrospective, interrupted time-series analysis that we conducted while waiting to launch the second study, a pragmatic, cluster randomized trial. In the first study, we analyzed data from 207 facilities in Gauteng and North West provinces where over 600 youth started internships between November 2018 and October 2019, examining changes in outcomes before versus after intern placements. We found placement of YHA interns was associated with significant improvements in monthly trends for numbers of people tested for HIV, newly initiated on treatment, and retained in care. In the second study, we randomized 20 facilities in one district of North West province to receive the YHA intervention (program and administrative interns versus only administrative interns) between October 2020 and August 2021. We performed an intention-to-treat and as-treated analysis. This was a largely null trial, except for a

significant increase observed in HIV testing immediately following placement of program interns. Overall, we believe the time series analysis results were more robust than the randomized trial, and the latter may have underestimated impact of the YHA program due to limitations in study design and timing of implementation (i.e., COVID-19).

Aim 2: We conducted a convergent mixed methods study to assess healthcare worker acceptance and perceived appropriateness of YHA as implemented in Gauteng and North West provinces. We surveyed 66 healthcare workers who provided supportive supervision to interns and analyzed the quantitative data descriptively; in parallel, we interviewed 33 healthcare workers who worked alongside YHA interns and analyzed the qualitative data inductively. We merged quantitative and qualitative results using a slightly modified version of the Theoretical Framework of Acceptability. Healthcare workers found the YHA program to be an acceptable and appropriate strategy to support HIV service delivery because they found its benefits—to healthcare workers, interns, and patients—to outweigh its burdens.

Aim 3: We conducted a costing study of the YHA program from the provider perspective (i.e., program implementers, such as the YHA organization and healthcare workers) to support an understanding of the program's affordability, facilitate decisions on implementation, and improve program efficiency. We used bottom-up and top-down methods to estimate the total incremental costs of the YHA program when it was in steady-state from March 2020 to September 2021. We reviewed costs by cost categories, actor, and program activity and estimated the cost to scale-up the program across South Africa. The cost of the YHA program was found to be comparable to existing lay health worker programs in South Africa, and we hypothesize that it would be affordable at scale, especially considering the different donors that this multisectoral approach could attract.

Conclusions: Placing unemployed youth as temporary lay health workers at health facilities appears to be an impactful, acceptable, appropriate, and affordable strategy to strengthen the HIV response in South Africa. This multisectoral program offers a novel approach to strengthen human resources for HIV services and the broader health sector.

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CHAPTER 1: Introduction

The future of global health will require increasingly multisectoral solutions to successfully address the complex problems of the world (1). This dissertation evaluates a novel multisectoral program, called Youth Health Africa, that works at the intersection of three pressing global health problems—HIV, healthcare worker shortages, and youth unemployment—to impact change.

Intersecting Challenges

An estimated 37.7 million people were living with HIV in 2020 (2). While the global community has made substantial strides in HIV testing, treatment, and viral suppression in the past decade, progress must accelerate to end the epidemic (2,3). By 2020, the world was very close to meeting the UNAID's 90-90-90 treatment targets for HIV, yet even so, an estimated one-quarter of people living with HIV were not on treatment, one-third of people living with HIV were not virally suppressed, and progress in preventing new infections had been slow (2). Economically disadvantaged young people remain especially at risk for HIV (4).

While HIV is a chronic medical condition that necessitates access to healthcare, the World Health Organization estimates that there could be a shortage of 18 million healthcare workers by 2030, with this gap being most prominent in low- and middle-income countries (5). Lay health workers, defined as people without professional or paraprofessional training (6), can be a tremendous support to health systems, presuming they receive sufficient training and supervision (7,8). In recent years, there has been much emphasis on the need for community health workers, a subset of lay health workers, but facility-based lay health workers can also have a role in supporting the health system, including HIV services (9–13). Despite widespread interest in lay health worker programs, funding for these programs has been sparse (7,14).

Meanwhile, there are high levels of youth unemployment in low- and middle-income countries. Globally, an estimated 17.2% of youth aged 15-24 years old were unemployed in 2020 (15), and youth unemployment grew during COVID-19 pandemic (16). While it is difficult to determine causal relationships between unemployment and health, youth unemployment has been associated with increases in risky

behavior and poorer health (17,18). In particular, being economically vulnerable is considered a driver of HIV amongst young people, particularly amongst young women in sub-Saharan Africa (4).

South Africa experiences all the challenges described above. South Africa has the greatest absolute burden of HIV, being home to 20% of people living with HIV globally (2). The South African government thus operates the largest ART program in the world, but there remain challenges initiating and retaining people on treatment (2,19,20). New infections amongst young people have changed little over time (19), suggesting the epidemic is far from over. More work is required to achieve the 95-95-95 targets to end HIV by 2030 (20,21), but the healthcare system is already overstretched (5,22). Lay health workers, specifically community health workers, have been used to bridge this gap, but funding constraints have limited their availability (23,24). Meanwhile, South Africa faces severe youth unemployment. The government estimates that in 2019, more than half of South African youth with a secondary education were unemployed, a number that was likely exacerbated by COVID-19 (25,26).

A novel solution

Youth Health Africa (YHA) is a South-African non-governmental organization that describes itself as "a youth-focused organization addressing key social determinants of health and youth unemployment through various integrated and innovative interventions" (27). The program places unemployed young adults who lack work experience in health facilities for a one-year non-clinical internship to support HIV services. In other words, youth interns temporarily assume the role of lay health workers that support HIV-related program and administrative tasks at health facilities. YHA's primary goal is to empower youth economically by providing them with work experience; its secondary goal is to reduce human resource challenges at facilities and improve delivery of HIV services.

The YHA program is unique for three reasons. Most notably, it is novel as it brings a youth workforce training program into the health sector. YHA was modeled after popular existing youth workforce training programs used in the for-profit sector in South Africa (e.g., Yes4Youth) (28), but to the best of our knowledge, it is the first program of its kind in the health sector. Secondly, YHA offers a new approach to lay health workers. The YHA program employs youth without experience as lay health workers for a short-term assignment, while traditionally, lay health workers in South Africa are older with more experience

and given longer contracts (23). Thirdly, the program has an untraditional funding source for public health programs: the private sector. YHA's focus on youth employment means it has been predominantly funded by private businesses in South Africa, which are incentivized to invest in the South African workforce through the country's Broad-based Black Economic Empowerment policy.

Dissertation Research

The YHA program has placed more than three-thousand youth as temporary lay health workers in health facilities across South Africa since it began in 2018. There is a need to understand how the YHA program has performed and been received in health facilities and to understand if this is an approach that should be continued in the health sector. We conducted research to evaluate the impact, acceptability, appropriateness, and cost of placing young adults as lay health worker interns in health facilities to strengthen the delivery of HIV services in South Africa.[1] This dissertation is comprised of four research studies that address the following aims:

- Aim 1: Quantify the impact that placement of youth interns in health facilities has on HIV service delivery.
- Aim 2: Describe the acceptability and appropriateness of YHA from the healthcare worker perspective and identify factors promoting or hindering high acceptability and perceived appropriateness.
- Aim 3: Estimate the cost of the YHA program from the provider perspective to support an understanding of the program's affordability, facilitate decision-making on implementation, and improve program efficiency.

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[1] There may also be broader societal impacts of YHA due to the program's focus on youth employment and empowerment, but assessing these were outside the scope of our research.

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CHAPTER 2. Does a Youth Intern Program Strengthen HIV Service Delivery in South Africa? An Interrupted Time-Series Analysis

Deanna Tollefson[1], Sayan Dasgupta[2], Geoffrey Setswe[3, 4], Sarah Reeves[5], Gavin Churchyard[3], Salome Charalambous[3,6], Ann Duerr[1, 2]

1: University of Washington, Department of Global Health, Seattle, United States

2: Fred Hutchinson Cancer Research Center, Vaccine and Infectious Disease & Public Health Science Divisions, Seattle, United States

3: The Aurum Institute, Implementation Research Division, Parktown, South Africa

4: Department of Health Studies, University of South Africa, Pretoria, South Africa

5: Youth Health Africa, Parktown, South Africa

6: School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

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INTRODUCTION

While global resources allocated to HIV care and prevention have greatly expanded, efforts failed to reach the 90-90-90 testing and treatment targets UNAIDS set for 2020 [1,2]. South Africa, which is home to one-in-five people infected with HIV globally [3], made significant progress towards these targets but must expand efforts to reach the more ambitious 95-95-95 targets set for 2030 [4,5].

The shortage of workers at health facilities has long been a significant challenge for delivery of HIV prevention and care in South Africa, as it is across Sub-Saharan Africa [6,7]. Use of lay health workers (LHWs), such as lay counselors, can bridge the staffing gap for HIV service delivery and has been promoted by the World Health Organization as a key strategy for achieving public health goals [7,8]. Nonetheless, uptake of LHWs has been slow in many places [9–11]. South Africa has relied heavily on LHWs to support HIV programs, but the supply of LHWs is insufficient to meet current needs [12,13].

While LHWs are scarce and health systems are understaffed, countries across Sub-Saharan Africa are also experiencing a youth unemployment crisis [14,15]. National 2019 unemployment statistics showed that, among people with secondary education, more than half in the 15-24 age group and one-third in the 25-34 age group were unemployed in South Africa [16]. During the COVID pandemic, these numbers have likely grown [17].

The Youth Health Africa (YHA) program was developed in South Africa to address this dual burden of shortages of HIV healthcare workers and high youth unemployment [18]. YHA places young adults needing work experience as non-clinical interns in health facilities, where they work as temporary LHWs. These interns support facility-based healthcare workers to perform programmatic tasks, like HIV testing and counseling, and administrative roles, like data entry and filing. While LHW programs are highly variable, most programs in Sub-Saharan Africa have improved patient care and health service delivery [19–29]. However, YHA is unique in that it uses younger workers with less upfront training and shorter contracts than traditional LHW programs. An assessment of the potential impact of these untapped human resources on the facility-based HIV response in South Africa is needed.

METHODS

Study Design

We conducted interrupted time series analyses using monthly program data to explore the facility-level impact of YHA on HIV service delivery and uptake in Gauteng and North West (NW) provinces in South Africa. We examined differences in time trends for seven routinely collected HIV indicators related to HIV testing, treatment initiation, and retention in care (see 'outcomes') before and after the implementation of YHA, under the assumption that the original time trend for indicators would remain unchanged in the absence of the YHA intervention. The expected time trend thus served as the counterfactual, and changes from the pre-intervention monthly trends for these indicators could cautiously be attributed to YHA [30]. To strengthen this interpretation, we conducted one additional analysis with an indicator that we would not expect to change and compared the differences in trends for the outcomes of interest with this unrelated indicator. We also stratified each analysis to examine changes to trends stratified by intern roles, number of interns at the facility, and geography.

Youth Health Africa and Intern Placement

YHA is a South African non-governmental organization funded primarily by local business donations paid to comply with South African social responsibility policies [18]. YHA began in late 2018, with the first interns placed in NW and Gauteng; it has since been implemented at hundreds of facilities associated with PEPFAR in South Africa. In YHA, interns between 18 and 30 years old, with a secondary education but no work experience, are placed in health facilities serving communities where they live. YHA provides a brief orientation (approximately one week); hosting health facilities provide extra training as necessary. Interns are given one-year placements in programmatic (e.g., HIV testing counselors, patient navigators, or tracers) or administrative (e.g., administrative clerks or data capturers) roles. While interns work primarily in their assigned roles, they support other tasks as needed. Multiple interns may be placed at a single facility, and interns are placed when funding becomes available, meaning start dates vary.

Eligibility Criteria

This study included facilities where Aurum Institute was the PEPFAR implementing partner and YHA interns were first placed between November 2018 – October 2019, which was the first year of the YHA

program. This includes facilities in NW and Gauteng, predominantly rural and urban environments, respectively. The study defined YHA as being implemented at a health facility if there was at least one intern who worked for a minimum of 90 days at the facility. (While placements normally last one year, interns could resign or be reassigned before the completion of one year.)

Outcomes

We analyzed eight monthly reported outcomes, which were selected based on YHA's theory of change (Figure 2.1) and the availability of data. For testing, we analyzed number tested for HIV *(hts_tst)* and number positive for HIV *(hts_pos)*. For treatment initiation, we analyzed number of people who were newly initiated on treatment (*tx_new)* and number of people who were initiated on treatment within 14 days of diagnosis *(initiated_14days)*. For retention in care, we analyzed number of people with an outcome of loss to follow up (LTFU) *(outcome_ltf)*, number of people completing viral load testing within six months of treatment initiation *(vl_completed_6mth)*, and number of people virally suppressed six months after treatment initiation *(vlsupp_6mth)*. The outcome for the comparator analysis was the number of people initiated on isoniazid preventive therapy (IPT) *(ipt_start).* We chose to analyze numbers rather than proportions due to availability of data, quality of data, and stakeholder interest.

Defining Intervention Start

The start of the intervention was defined as the month a facility hosted its first intern, which varied by facility, occurring sometime between November 2018 – October 2019. Due to variation in start dates, we centered analyses on 'time zero', the time the intervention started at a facility, which we rounded to the nearest month (e.g., if an intern started on March 20, their start date would be set to April 1). Negative time corresponded to months before the facility had an intern; positive time corresponded to months since the first intern started at the facility.

Time Period

This study includes 30 months of data from October 2017–March 2020 for all outcomes except viral load indicators, for which data were only available from October 2018–March 2020. This analysis did not extend past March 2020 due to program disruptions associated with the advent of COVID-19.

Data Sources and Preparation

Two datasets were required for this analysis: an intervention dataset to measure the exposure (intern placement) and a facility dataset to measure the outcome (HIV indicators). We created the intervention dataset by compiling YHA program data on interns: the health facilities where interns were placed, internship start and end dates, and intern roles. We compiled the outcome dataset from facility-level data from TIER.Net, the national HIV surveillance system, that was reported to Aurum. The outcome dataset included monthly data reported from October 2017–March 2020 for all Aurum-affiliated facilities in Gauteng and NW. The intervention dataset was aggregated by facility and merged with the facility dataset in R 3.6.1 (R Core Team 2019, Vienna, Austria) by facility name. Data were cleaned in Stata 15 (StataCorp 2017, College Station, TX: StatCorp LLC).

Due to facilities having different start dates, facilities had variable number of data points in the pre-intervention and intervention periods, with sparse data at extreme timepoints. Time points were considered extreme and excluded from the analysis if they included data from fewer than half of facilities; extreme time points were found to be those 20 months or more before start of the intervention and those 11 or more months after start of the intervention. The final dataset contained 30 months of data, of which about two-thirds of time points (19/30 months) included data from all facilities.

Data Analysis

We used segmented linear regression to model absolute number of outcomes with restricted maximum likelihood estimates (REML). We used “nlme” package in R to run analyses [31], adjusting for autocorrelation (AR1) and facility-level clustering. We chose *a priori* to run models with slope changes but not immediate level changes because we hypothesized that YHA would result in gradual change. We ran all models using random intercepts and selected parsimonious models to maximize interpretability, even if a more complex model may have fit the data better.

We conducted eight primary time series centered at time zero: one analysis for each outcome of interest and one for the comparator. The base model was as follows:

$$Y_{ijt} = \beta_0 + \beta_1 \text{timecentered}_{ijt} + \beta_2 \text{timeafterint}_{ijt} + E_{ij}$$

In these models, β_1 equaled the slope of the pre-intervention period, $\beta_1 + \beta_2$ equaled the slope of the intervention period, and β_2 equaled the difference in slope between the intervention and pre-intervention periods. All time was measured in number of months since the start of the intervention. We tested the null hypothesis that there was no difference in slope after the intervention ($\beta_2=0$), which we assessed at the 0.05 significance level.

In addition to the primary analyses, we ran secondary analyses: three additional time series per outcome, stratified by region, number of interns, and role of interns. The stratified model was as follows:

$$Y_{ijt} = \beta_0 + \beta_1 \text{timecentered}_{ijt} + \beta_2 \text{timeafterint}_{ijt} + \beta_3 \text{stratavariable}_{ijt} + \beta_4 \text{timecentered*stratavariable}_{ijt} + \beta_5 \text{timeafterint*stratavariable}_{ijt} + E_{ij}$$

In the stratified model, β_2 equaled the difference in slope between the intervention and pre-intervention periods for strata 1, while $\beta_2 + \beta_5$ equaled this difference for strata 2, and β_5 was the difference in the change in slope between strata (difference-in-difference). For these secondary analyses, we assessed whether there was a change in slope from pre- to intervention period for each stratum (null hypotheses: $\beta_2=0$, $\beta_2 + \beta_5=0$) and whether this change differed by strata (null hypothesis: $\beta_5=0$), both of which we assessed at the 0.05 significance level.

In addition, we conducted two sensitivity analyses, running the primary analyses (1) with an immediate level change and (2) with both random intercepts and slopes.

All models were plotted using package “ggplot2” in R [32].

Ethics

This study was approved by the University of Witwatersrand (Johannesburg, South Africa) ethics committee.

RESULTS

Participating Facilities

This analysis included 207 facilities, predominantly clinics, with 604 interns who started placements between November 2018 and October 2019 (Table 2.1). Two-thirds of eligible facilities were in NW, but 60% of interns worked in Gauteng. The number of interns placed per facility varied widely (1 to 18), with facilities in Gauteng having more interns on average than those in NW. More interns served in

administrative than program roles, with almost two-thirds of participating facilities in NW having only administrative interns.

Primary Analysis

After the introduction of the YHA program, there was a significant increase in trends for the number of people tested for HIV, newly initiated on treatment, completing viral load testing, and virally suppressed, and a significant decrease in trends for the number of people lost to follow-up (Figure 2.2). These trends all moved in the direction of program improvement. The change from pre-intervention to intervention period was greatest for HIV testing, with a difference in slope of 24.5 (95% CI: 18.4, 30.5) people per month. The differences observed for other outcomes with significant findings were much smaller, each being <1 person per month (Table 2.2). We did not observe significant changes in slope for the number of people testing positive for HIV or for the number of people who were initiated on treatment within 14 days of diagnosis. The time trend for the comparator indicator showed no clear trends from pre-intervention to intervention despite there being a significant decrease in slope.

Secondary Analyses

Secondary analyses showed that for many outcomes there were differences in level and trend between strata in the pre-intervention period, which were often amplified in the intervention period (Figure 2.3). Pre-intervention, facilities that would receive program interns or 5 or more interns had a significantly stronger trend towards improvement for many outcomes than facilities that would receive only administrative interns or 1-2 interns. When YHA was implemented, facilities with program interns, facilities with more interns, and facilities in Gauteng experienced significant changes in trends for more outcomes than facilities with only administrative interns, facilities with 1-2 interns, and facilities in NW (Table 2.3); the magnitude of changes from pre- to intervention period also tended to be greatest in these facilities (Figure 2.3). Results of the LTFU analysis were unique as improvements in trends were found only for facilities with administrative interns, 1-2 interns, and in NW. The analysis of treatment initiation within 14 days was also unique, as trends were significantly reduced after the intervention except in facilities with program interns, 5 or more interns, or in Gauteng. Full model results can be found in Appendix A.

Sensitivity analysis

Models run with a parameter for level change when interns were placed did not yield noticeable changes in the effect size or statistical significance for difference in trends as compared to the models used in the primary analysis, but analyses for HIV testing, HIV positive cases, and new treatment initiation did have significant increases in level changes (Appendix B). Models run with random intercepts and slopes did not converge for the loss to follow-up and IPT outcomes. Where models did converge, there were no changes in significance and minimal changes in effect size, with the exception for viral load indicators, which did not see significant change in slope from pre- to post-intervention in the new models (Appendix C).

DISCUSSION

Our study suggests the use of youth interns as LHWs may be an impactful strategy to strengthen components of HIV service delivery at health facilities. In our time series analyses, we observed improvements in trends for HIV testing, treatment initiations, LTFU, and viral load testing and suppression, but we did not observe changes in trends for positive diagnoses or rapidity of treatment initiation. Trends for the comparator indicator declined, but as we predicted, did not follow a clear pattern based on implementation of YHA. We generally observed more change when facilities had interns working in programmatic roles, as well as when more interns were placed at a facility (i.e., a dose-response effect), which aligns with the overarching theory of change for the program. Stratification by location mirrored stratification by intern role as most facilities in Gauteng had interns in programmatic roles while facilities in NW had predominantly only administrative interns. Together, these findings suggest that the YHA program, when implemented with sufficient interns, specifically program interns, may help facilities strengthen aspects of HIV programming.

In many ways, our positive results are not surprising. Our finding that the YHA program is associated with an increase in HIV testing echoes past research that has found HIV testing numbers increase in facilities with lay counsellors, primarily because there are more people available to do HIV testing and counseling [19,23,24]. Similarly, our findings that treatment initiations increased with the placement of interns may be expected as prior research suggests peer navigators may improve social support and build trust among

patients, which could lead to increased ART uptake [25,26,28,29], although an impact of peer navigators on ART initiation has not always been observed [21,27]. It may be more likely that the interns contributed to an increase in treatment initiations by improving clinic operations (e.g., clinic flow, wait times), as evidence in the literature is strongest that LHWs indirectly impact ART uptake in this manner [27].

The analyses examining retention outcomes were more surprising. In contrast to other outcomes, the reduction in LTFU cases was closely linked to presence of administrative, not program, interns, which suggests YHA may have impacted LTFU by improving data quality. While this is different than what we expected, it aligns with past research that suggests LTFU is a data quality problem as much as a program issue in South Africa [33,34]. Interventions that improve accuracy of LTFU data are thus considered critical to improve routine tracing efforts for LTFU [34], underscoring the importance of LHW programs like YHA that may support improved record keeping. In contrast, we are less confident in YHA's impact on the second group of retention outcomes—viral load indicators—due to lack of changes observed after the intervention in the sensitivity analysis and the shorter period for the analysis. It may be that viral load indicators increased rapidly at all sites during the study period because 90-90-90 brought greater attention to viral load monitoring, but these changes may have been accelerated by program interns.

It is also important to review the outcomes for which there were no changes in trend after YHA implementation. The lack of change in number of positive HIV cases despite increased testing highlights that facility-based testing, even if expanded, may struggle to find HIV-positive individuals who do not know their status. The YHA approach could be more effective at finding new positives if, in addition to supporting HIV testing at facilities, interns facilitated alternative testing approaches in the community (e.g., home-based testing) [35,36]. Trends for treatment initiation within 14 days of diagnosis also failed to increase after the intervention, even though overall treatment initiations increased. This may be because treatment initiation involves multiple steps, many of which cannot be directly affected by LHWs (e.g., initial clinical evaluations) [37]. Thus, interns might increase the number of people initiated on treatment, but not the speed at which each of these steps occurs.

Finally, we must consider the differences in impact we observed based on intern type, number, and geography. After YHA was implemented, differences in outcomes by intern type and number aligned with

the theory of change, while differences by location mirrored those observed for intern roles, due to most program interns being in Gauteng. However, stratum-specific differences observed in the pre-intervention period suggest that pre-existing differences between facilities may have influenced how many and what type of interns they received. Facilities that received more interns and program interns may have been predisposed to success due to unmeasurable facility-level factors (e.g., leadership) that could have impacted outcomes in both the pre-intervention and intervention time periods.

Limitations

Our research highlights how data from routine health information systems can be used to evaluate ongoing public health programs, but it also highlights the limitations of using retrospective, programmatic data and relying on quasi-experimental study designs. The quality and breadth of available information for both the exposure (intern placement) and outcomes (facility-level HIV indicators) was limited by what was captured in routine practice. Our outcomes were limited to indicators collected monthly during the period of interest. We also lacked data on facility performance and how YHA was implemented at each facility (e.g., daily intern attendance, frequency of supportive supervision), which is necessary to provide a more nuanced analysis. The number of months we could include in the intervention period for this analysis was also limited by COVID-19, which hinders our long-term understanding of YHA.

In addition, we recognize the limitations of drawing causal inference from a time series analysis [30]. We could not identify facilities as controls for this analysis, as there were undoubtedly fundamental differences between facilities that received the intervention and those that did not. Moreover, we could not control or explain why facilities received their given number or type of interns. Similarly, we could not account for underlying differences between facilities that were present prior to the intervention and may have affected receipt and impact of the intervention (i.e., unmeasured confounders). Finally, we recognize the heterogeneity in outcome data between facilities, resulting in imperfect fit for many linear models in the primary analysis. Nonetheless, the analyses as conducted have enabled us to observe broad trends, which were most important to stakeholders.

Recommendations

Ultimately, more research on the YHA approach is needed to understand its possible impact on health facilities. A cluster randomized trial of facilities could be useful to further examine the impact suggested by this study (see Chapter 3), and further implementation science and qualitative research would also be useful to understand other ways that YHA could affect facilities, as research suggests LHW programs may contribute to facility improvements not captured by health indicators [20] (see Chapter 4). Qualitative research could also highlight the mechanism of change for this program, which we could not elucidate from this study. In addition, there is a need to understand healthcare worker perceptions on this program (see Chapter 4), as perceived acceptance and appropriateness of the program are vital to implementation success [38].

CONCLUSION

Our study suggests that use of youth interns as lay health workers may be an impactful strategy to strengthen HIV service delivery at health facilities. While interns did not appear to influence all aspects of HIV service delivery and may not affect outcomes if deployed in low numbers, their ability to impact any facility-level outcomes suggests they could be an untapped source of LHWs to support health facilities deliver HIV programs. As the HIV and unemployment epidemics in South Africa are mirrored across Sub-Saharan Africa, this innovative strategy may be of interest to other countries seeking to improve their HIV response and support youth employment.

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TABLES

Table 2.1. Characteristics of the Youth Health Africa facility-based intern program as implemented in Aurum-affiliated sites in Gauteng and North West provinces, South Africa (11/2018 – 10/2019).

	Gauteng (N=74 facilities)	**North West (N=133 facilities)**	**Total (N=207 facilities)**
Facility Type			
Clinic	64 (86.5%)	103 (77.4%)	167 (80.7%)
Community Health Center	4 (5.4%)	21 (15.8%)	25 (12.1%)
Hospital	4 (5.4%)	7 (5.3%)	11 (5.3%)
Unspecified	2 (2.7%)	2 (1.5%)	4 (1.9%)
Average no. Interns per facility (SD)			
All Interns	4.9 (3.8)	1.8 (1.3)	2.9 (2.9)
Program Interns	2.7 (2.4)	0.4 (0.6)	1.3 (1.9)
Total Interns per facility (%)			
1 or 2	21 (28.4%)	110 (82.7%)	131 (63.3%)
3 or 4	19 (25.7%)	18 (13.5%)	37 (17.9%)
5 or more	34 (45.9%)	5 (3.8%)	39 (18.8%)
Total Facilities with Program Interns (%)	60 (81.1%)	46 (34.5%)	106 (51.2%)
Avg no. Rounds of Intern Placements (SD)	3.0 (1.6)	1.2 (0.5)	1.8 (1.4)
Avg no. Interns placed in first round (SD)	1.6 (1.1)	1.5 (0.9)	1.6 (1.0)
Total no. Interns*	364 (60.2%)	240 (39.7%)	604 (100%)

*SD = Standard deviation * Row % are provided*

Table 2.2. Results for the primary analysis regression models, including parameter coefficient and 95% confidence intervals.
Models are $Y = \beta_0 + \beta_1 timecentered + \beta_2 timeafterint$, with change in slope ($\beta_2$) being the parameter of interest. Analyses included 207 facilities.

	Intercept (β_0)	Slope Pre-Intervention (β_1)	Slope Post-Intervention ($\beta 1+\beta 2$)	Change in Slope (β_2)	p-value for β_2
Testing					
Tested for HIV*	387 (339, 435)	11.3 (8.8, 13.9)	35.8 (27.2, 44.4)	24.5 (18.4, 30.5)	<0.0001
Positive for HIV	33.2 (28.9, 37.4)	0.27 (0.18, 0.36)	0.40 (0.07, 0.7 3)	0.13 (-0.11, 0.37)	0.2971
Treatment Initiation					
Newly Started on Treatment*	29.1 (25.3, 33.0)	-0.03 (-0.11, 0.05)	0.56 (0.27, 0.85)	0.59 (0.37, 0.80)	<0.0001
Initiated on Treatment in 14 days	20.7 (17.7, 23.6)	0.40 (0.28, 0.51)	0.20 (-0.21, 0.61)	-0.20 (-0.49, 0.10)	0.1944
Retention in Care					
Lost to Follow Up*	6.4 (5.2, 7.6)	-0.34 (-0.41, -0.27)	-0.71 (-0.97, -0.44)	-0.37 (-0.56, -0.18)	0.0002
Viral Load Test Completed*	7.1 (5.7, 8.4)	0.36 (0.14, 0.59)	1.15 (0.59, 1.70)	0.78 (0.45, 1.11)	<0.0001
Viral Load Suppressed*	5.8 (4.6, 7.0)	0.34 (0.13, 0.55)	1.04 (0.52, 1.55)	0.70 (0.39, 1.00)	<0.0001
Comparator					
Initiated IPT*	41.1 (36.6, 45.6)	1.04 (0.77, 1.31)	-0.87 (-1.86, 0.12)	-1.91 (-2.63, -1.19)	<0.0001

**significant at a 95% CI (p<0.05)*

Table 2.3. Direction and significance of trend change in the secondary analyses (intervention vs. pre-intervention) (p<0.05).
The '+' symbol indicates significant change in the positive direction; the '-' symbol indicates significant change in the negative direction; and blank cells indicate insignificant changes in slope.

	Tested for HIV	HIV Positive	New Txt Initiations	Initiated within 14 days	Lost to Follow Up	Viral Load Completed	Viral Load Suppressed
Intern Type							
Admin interns only	+			-	-		
Program interns	+		+			+	+
Difference (Prog. vs. Admin change)	+	+	+	+		+	+
Number of Interns							
1 or 2 interns	+			-	-		
3 or 4 interns	+		+				
5+ interns	+		+			+	+
Difference (3-4 vs. 1-2 change)	+		+			+	+
Difference (5+ vs 1-2 change)	+		+			+	+
Region							
North West	+	-		-	-		
Gauteng	+	+	+			+	+
Difference-in-difference	+	+	+	+		+	+

FIGURES

Figure 2.1. Theory of Change for the Youth Heath Africa intern program. Solid lines represent direct impact. Dotted lines represent indirect impact.

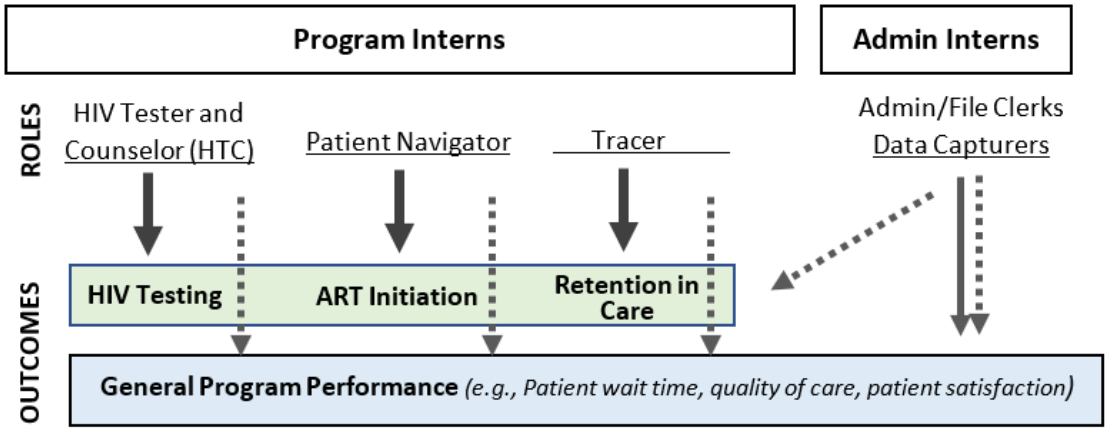


Figure 2.2. **Primary time series analysis**: Monthly reported HIV indicators from health facilities in EKN and NW, South Africa, centered at time of YHA intern placements at facility. Points are average outcomes per month. Black lines represent the model. Dotted lines represent the corresponding 95% confidence intervals. Red lines indicate the start of the intervention at each facility (time=0 months). All models cover calendar time October 2017-March 2020, except for viral load indicators which cover calendar time October 2018-March 2020.

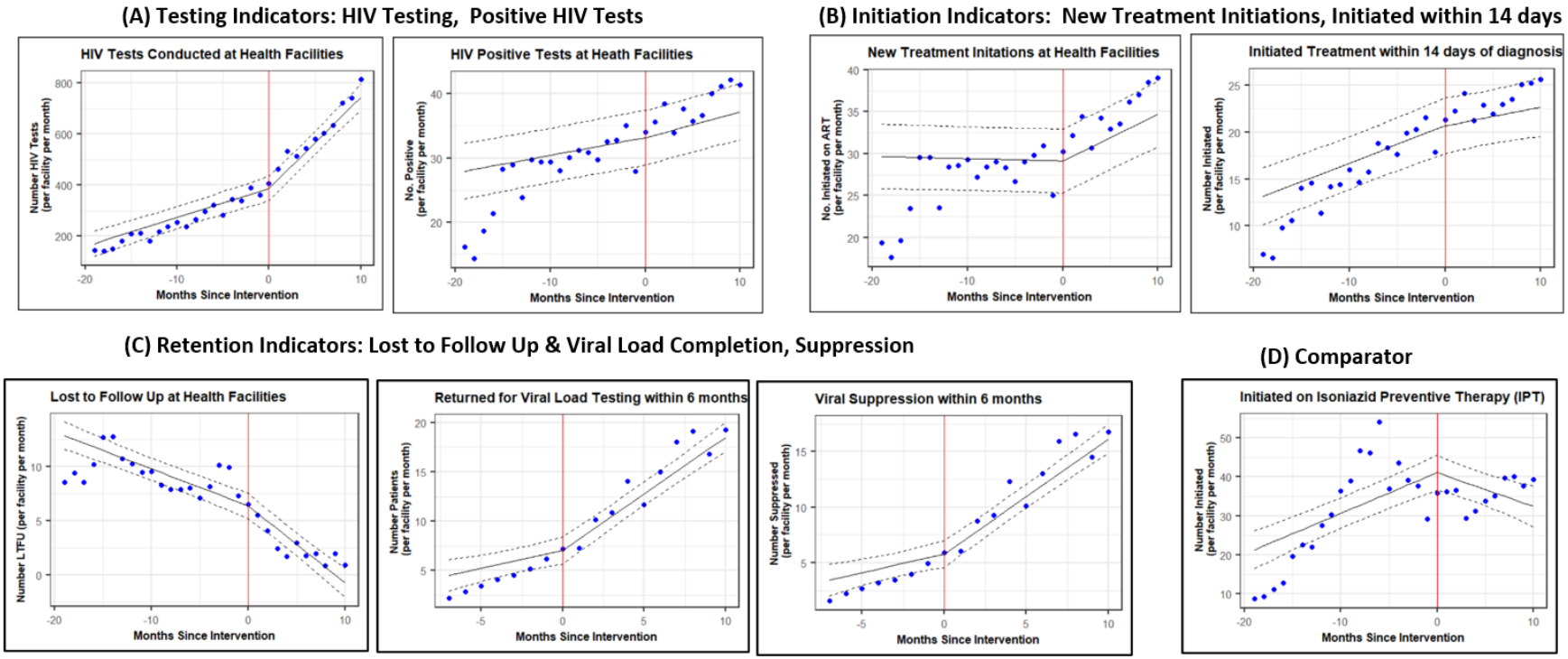
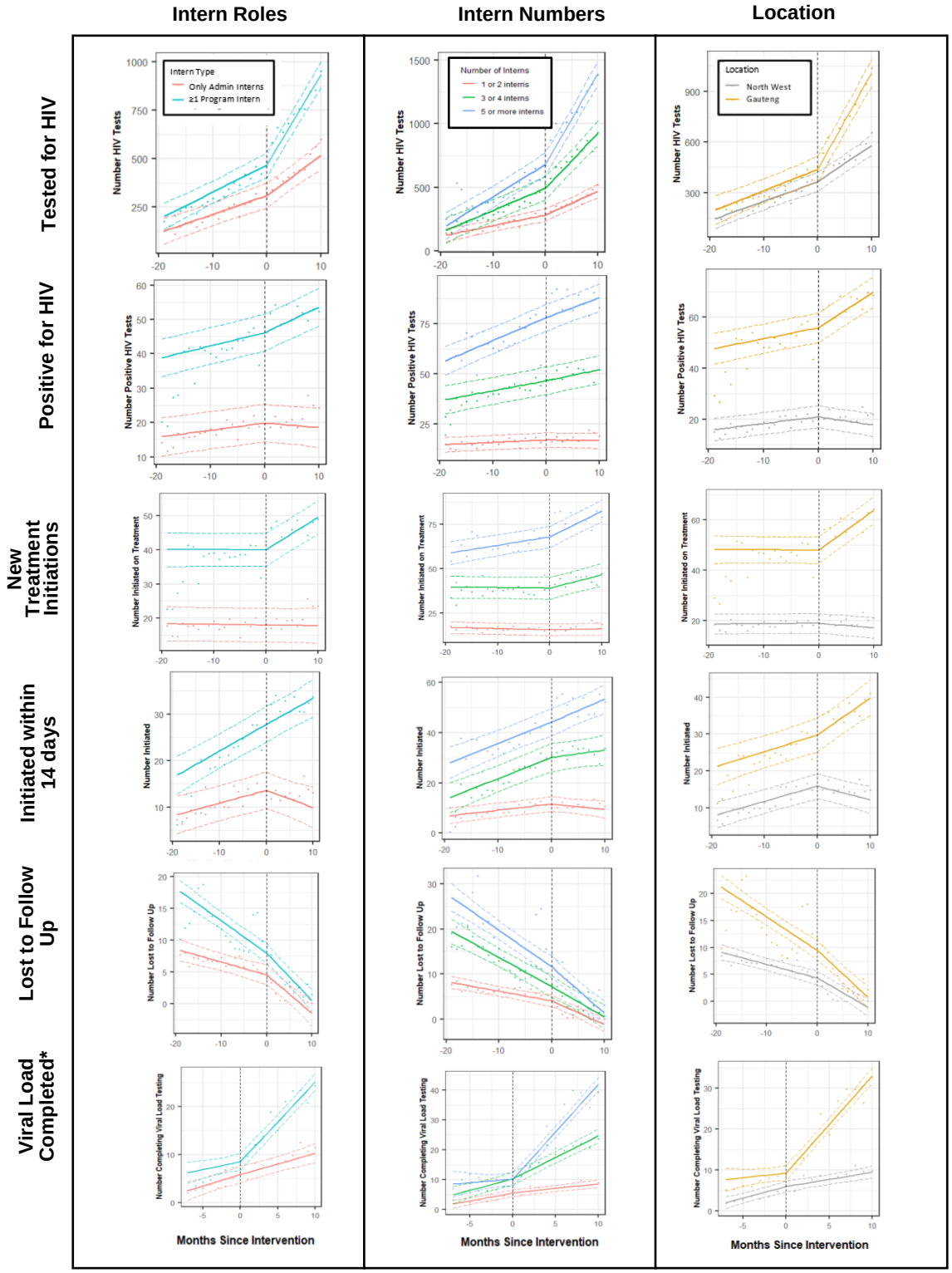


Figure 2.3. Secondary time series analyses (stratified): Monthly reported HIV indicators from health facilities centered at time of YHA intern placements at facility. Points are average outcomes per month. Solid lines represent the model. Dotted color lines represent 95% confidence intervals. Dotted, vertical black line indicates start of intervention at facility (time=0 months). All models cover calendar time October 2017-March 2020, except for viral load indicators which cover calendar time October 2018-March 2020. *Viral load suppressed mirrored viral load completed.



APPENDIX A: Model parameters for secondary analysis

Table 2A.1: Model parameters representing slope change from each secondary analysis

Outcome		Point Estimate	95% CI Lower	95% CI Upper
TESTED FOR HIV				
	Region			
β2	North West	10.14894	2.948311	17.34956
β2 + β5	Gauteng	44.41687	25.11324	63.7205
β5	Difference-in-difference	34.26793	22.16492	46.37094
	Number of Interns			
β2	1 or 2 interns	10.28448	3.888887	16.68007
β2 + β7	3 or 4 interns	25.70552	5.964259	45.44679
β2 + β8	5+ interns	46.10401	26.0794	66.12863
β7	Difference-in-difference (3-4 vs. 1-2)	15.42105	2.075372	28.76672
β8	Difference-in-difference (5+ vs 1-2)	35.81954	22.19052	49.44856
	Intern Type			
β2	Admin interns only	11.0579	2.532809	19.58299
β2 + β5	Program interns	32.80174	12.55448	53.049
β5	Difference-in-difference	21.74384	10.02167	33.46601
HIV POSITIVE				
	Region			
β2	North West	-0.5913	-0.87624	-0.30635
β2 + β5	Gauteng	0.958115	0.192804	1.723426
β5	Difference-in-difference	1.549412	1.069048	2.029775
	Number of Interns			
β2	1 or 2 interns	-0.15653	-0.44041	0.127348
β2 + β7	3 or 4 interns	0.065042	-0.80882	0.9389
β2 + β8	5+ interns	-0.14043	-1.03271	0.751853
β7	Difference-in-difference (3-4 vs. 1-2)	0.221572	-0.36841	0.811552
β8	Difference-in-difference (5+ vs 1-2)	0.016101	-0.5923	0.624505
	Intern Type			
β2	Admin interns only	-0.34478	-0.69496	0.005406
β2 + β5	Program interns	0.358356	-0.47134	1.188049
β5	Difference-in-difference	0.703133	0.223623	1.182644

Continued on next page

Table 2A.1 continued

Outcome		Point Estimate	95% CI Lower	95% CI Upper
NEW TREATMENT INITIATIONS				
	Region			
β2	North West	-0.19128	-0.43954	0.056991
β2 + β5	Gauteng	1.595064	0.92827	2.261857
β5	Difference-in-difference	1.786339	1.367811	2.204867
	Number of Interns			
β2	1 or 2 interns	0.114386	-0.13645	0.365226
β2 + β7	3 or 4 interns	0.785695	0.013608	1.557782
β2 + β8	5+ interns	0.998427	0.209947	1.786906
β7	Difference-in-difference (3-4 vs. 1-2)	0.671309	0.150063	1.192556
β8	Difference-in-difference (5+ vs 1-2)	0.884041	0.346401	1.42168
	Intern Type			
β2	Admin interns only	0.002807	-0.30227	0.307879
β2 + β5	Program interns	0.947904	0.225157	1.67065
β5	Difference-in-difference	0.945097	0.527423	1.362771
NEW TREATMENT INITIATIONS WITHIN 14 DAYS				
	Region			
β2	North West	-0.78067	-1.13979	-0.42155
β2 + β5	Gauteng	0.560928	-0.40317	1.525025
β5	Difference-in-difference	1.341601	0.736624	1.946578
	Number of Interns			
β2	1 or 2 interns	-0.45652	-0.81117	-0.10187
β2 + β7	3 or 4 interns	-0.55221	-1.64573	0.541322
β2 + β8	5+ interns	0.077579	-1.03529	1.190446
β7	Difference-in-difference (3-4 vs. 1-2)	-0.09569	-0.83456	0.64319
β8	Difference-in-difference (5+ vs 1-2)	0.5341	-0.22411	1.292315
	Intern Type			
β2	Admin interns only	-0.64673	-1.06843	-0.22502
β2 + β5	Program interns	-0.01724	-1.01751	0.983034
β5	Difference-in-difference	0.62949	0.050924	1.208056

Continued on next page

Table 2A.1 continued

Outcome		Point Estimate	95% CI Lower	95% CI Upper
LOST TO FOLLOW-UP				
	Region			
β2	North West	-0.29123	-0.52496	-0.0575
β2 + β5	Gauteng	-0.2543	-0.88191	0.373313
β5	Difference-in-difference	0.03693	-0.35695	0.430813
	Number of Interns			
β2	1 or 2 interns	-0.30975	-0.5409	-0.0786
β2 + β7	3 or 4 interns	-0.02524	-0.73818	0.687707
β2 + β8	5+ interns	-0.21407	-0.93967	0.511523
β7	Difference-in-difference (3-4 vs. 1-2)	0.284512	-0.19728	0.766306
β8	Difference-in-difference (5+ vs 1-2)	0.095675	-0.39877	0.590122
	Intern Type			
β2	Admin interns only	-0.40495	-0.68061	-0.12929
β2 + β5	Program interns	-0.22909	-0.88303	0.424854
β5	Difference-in-difference	0.17586	-0.20243	0.554147
VIRAL LOAD TESTING COMPLETED (Within 6 months)				
	Region			
β2	North West	-0.21978	-0.55278	0.113225
β2 + β5	Gauteng	2.148391	1.173526	3.123256
β5	Difference-in-difference	2.368168	1.726306	3.01003
	Number of Interns			
β2	1 or 2 interns	-0.20554	-0.5108	0.09972
β2 + β7	3 or 4 interns	0.653459	-0.34987	1.656792
β2 + β8	5+ interns	2.932201	1.745339	4.119063
β7	Difference-in-difference (3-4 vs. 1-2)	0.858999	0.160926	1.557072
β8	Difference-in-difference (5+ vs 1-2)	3.137741	2.25614	4.019343
	Intern Type			
β2	Admin interns only	-0.03895	-0.4761	0.39819
β2 + β5	Program interns	1.3369	0.267942	2.405857
β5	Difference-in-difference	1.375852	0.744038	2.007667

Table 2A.1 continued

Outcome			Point Estimate	95% CI Lower
VIRAL LOAD SUPPRESSED (Within 6 months)				
	Region			
β2	North West	-0.20207	-0.5056	0.101459
β2 + β5	Gauteng	1.894769	1.006277	2.783262
β5	Difference-in-difference	2.096838	1.511874	2.681803
	Number of Interns			
β2	1 or 2 interns	-0.19885	-0.48116	0.083458
β2 + β7	3 or 4 interns	0.543131	-0.38443	1.470693
β2 + β8	5+ interns	2.784358	1.688822	3.879894
β7	Difference-in-difference (3-4 vs. 1-2)	0.741983	0.096732	1.387234
β8	Difference-in-difference (5+ vs 1-2)	2.983211	2.169985	3.796436
	Intern Type			
β2	Admin interns only	-0.07415	-0.47525	0.326944
β2 + β5	Program interns	1.23856	0.257855	2.219265
β5	Difference-in-difference	1.312712	0.733103	1.892322

APPENDIX B: Sensitivity Analysis (Immediate level change)

Figure 2.B1– Monthly reported HIV indicators from health facilities from model incorporating immediate level change ($Y = \beta_0 + \beta_1 timecentered + \beta_2 int + \beta_3 timeafterint$). Models are centered at time of YHA intern placements at facility. Points are average outcomes per month. Black lines represent the model. Dotted lines represent the corresponding 95% confidence intervals. Red lines indicate the start of the intervention at each facility (time=0 months). All models cover calendar time October 2017-March 2020, except for viral load indicators which cover calendar time October 2018-March 2020.

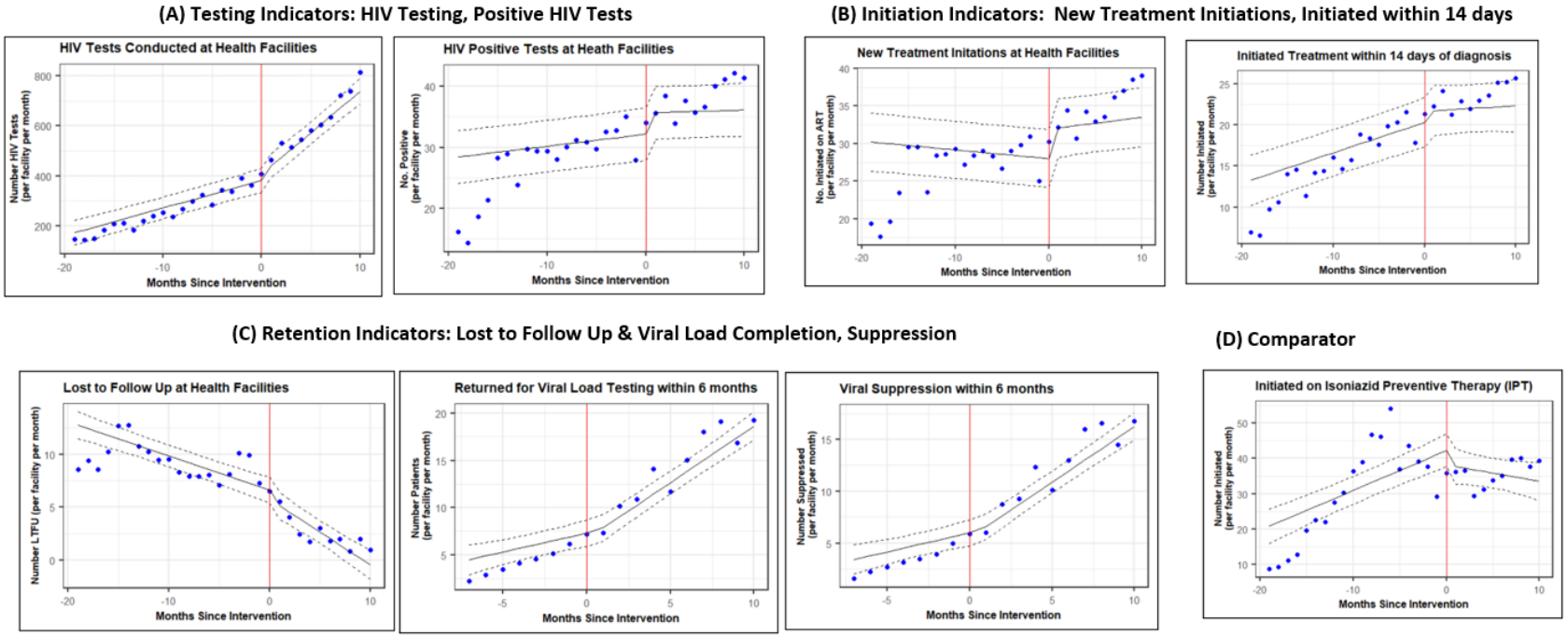
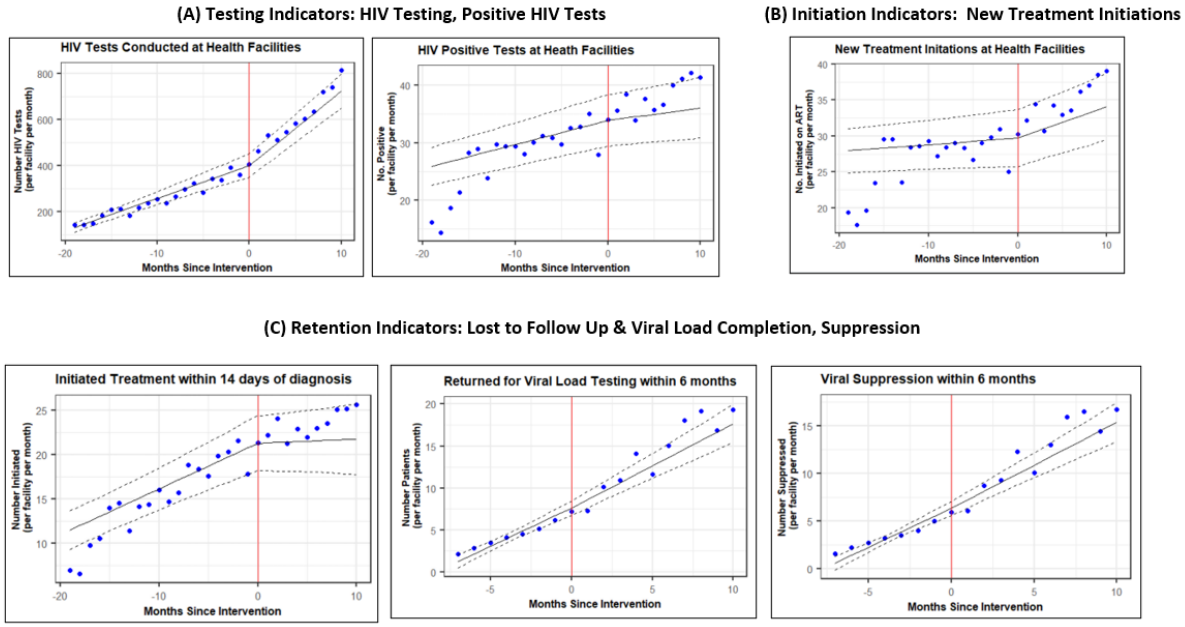


Table 2B.1: Parameters for model with immediate level change
($Y = \beta_0 + \beta_1 timecentered + \beta_2 int + \beta_3 timeafterint$)

	Point Estimate	95% CI Lower	95% CI Upper	Significance (p<0.05)
HIV Testing				
β_0	381.08765	332.7118	429.4635	x
β_1	10.95298	8.429353	13.47662	x
β_2	27.1325	5.080766	49.18424	Sig
β_3	22.1495	15.82013	28.47887	Sig
HIV Positive				
β_0	32.1727944	27.87541	36.47018	x
β_1	0.1953552	0.099427	0.291283	x
β_2	3.4955249	1.855821	5.135229	Sig
β_3	-0.1481338	-0.42205	0.125784	Not Sig
Treatment New				
β_0	28.0234459	24.16296	31.88393	x
β_1	-0.1153454	-0.19867	-0.03202	x
β_2	3.8970664	2.439263	5.354869	Sig
β_3	0.2741153	0.035033	0.513197	Sig
Treatment within 14 days				
β_0	20.3066287	17.31196	23.3013	x
β_1	0.3690165	0.251604	0.486429	x
β_2	1.3609958	-0.12423	2.846222	Not Sig
β_3	-0.3032958	-0.62124	0.014651	Not Sig
LTFU				
β_0	6.6213271	5.419002	7.823652	x
β_1	-0.3223343	-0.39772	-0.24695	x
β_2	-0.8592559	-1.83239	0.11388	Not Sig
β_3	-0.2985553	-0.50343	-0.09368	Sig
VL Completed				
β_0	7.2758032	5.855592	8.696014	x
β_1	0.4013863	0.16567	0.637103	x
β_2	-0.614975	-1.56172	0.331769	Not Sig
β_3	0.7972245	0.464517	1.129932	Sig
VL Suppressed				
β_0	5.9863602	4.724635	7.248085	x
β_1	0.3667501	0.150933	0.582568	x
β_2	-0.4810965	-1.34548	0.383286	Not Sig
β_3	0.7098319	0.404966	1.014698	Sig

APPENDIX C: Sensitivity Analysis (Random slope and intercept)

Figure 2.C.1– Outcomes for base model using random slope and intercept ($Y = \beta_0 + \beta_1 timecentered + \beta_2 timeafterint$). Models for the outcomes "lost to follow-up" and "isoniazid preventive therapy" did not converge while using random slope and intercept. Models are centered at time of YHA intern placements at facility. Points are average outcomes per month. Black lines represent the model. Dotted lines represent the corresponding 95% confidence intervals. Red lines indicate the start of the intervention at each facility (time=0 months). All models cover calendar time October 2017-March 2020, except for viral load indicators which cover calendar time October 2018-March 2020.



CHAPTER 3: Impact of youth lay health workers on HIV service delivery in South Africa: a pragmatic cluster randomized trial

Deanna Tollefson[1], Sayan Dasgupta[2], Geoffrey Setswe[3, 4], Sarah Reeves[5], Salome Charalambous[3,6], Ann Duerr[1, 2]

1: University of Washington, Department of Global Health, Seattle, United States

2: Fred Hutchinson Cancer Research Center, Vaccine and Infectious Disease & Public Health Science Divisions, Seattle, United States

3: The Aurum Institute, Implementation Research Division, Parktown, South Africa

4: Department of Health Studies, University of South Africa, Pretoria, South Africa

5: Youth Health Africa, Parktown, South Africa

6: School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

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INTRODUCTION

Lay health workers (LHWs), defined as persons who support health work without formal qualifications (1), offer great potential to promote health and reduce human resource challenges in the healthcare sector, especially in low and middle-income countries (2–5). LHW programs are considered a critical tool to help HIV programs improve reach and service delivery (6–9), but innovative approaches are needed to expand the reach of LHW programs, which are often limited by political and financial constraints (10,11).

Youth Health Africa (YHA) is an innovative LHW approach that has showed potential to support HIV service delivery at health facilities in South Africa (12,13). YHA places young adults as temporary LHWs at health facilities in communities implementing the program to support non-clinical tasks, ranging from HIV testing and counseling to filing patient records (12). This program stands in contrast to traditional LHW programs in South Africa, as it operates as an internship program, with a primary goal to provide young adults workplace training to improve their future employability and reduce youth unemployment (11,14). It is also primarily funded by private businesses in response to the country's Broad-based Black Economic Empowerment policy, whereas traditional LHW programs are government funded (11,15).

Rigorous evaluation is needed to assess the impact of YHA on health services to determine whether this LHW approach is effective in improving health care delivery, specifically in the HIV care sector. Past research has evaluated the YHA approach through observational studies (12,13), but the limitations to these methods are well established. We therefore conducted a pragmatic, cluster randomized trial to assess the impact that placement of youth interns in health facilities had on HIV service delivery.

METHODS

Study Design

We implemented a randomized trial among 20 facilities to compare the impact of YHA program interns on HIV testing, treatment initiation, and retention in care. This was a pragmatic trial as YHA implemented and monitored the program following its standard operations, and we measured impact using routinely reported facility-level HIV data. The intervention was in place from October 2020–August 2021. The YHA program has been described in detail elsewhere (12,13).

Setting

This study was conducted in health facilities in Ngaka Modiri Molema (NMM) district, North West province, South Africa. NMM is a semi-urban district in a rural province with high youth unemployment (16). NMM has been a focus district of the U.S. President's Emergency Fund for AIDS (PEFPAR) (17) and has a relatively high proportion of people who had been previously tested for HIV (18).

Study Arms

This was a two-arm study, with 1:1 randomization at 20 purposively sampled health facilities. There were 10 facilities in each arm. All 20 facilities received a minimum package: 1-2 interns assigned to administrative roles, such as filing or data capture (henceforth called "admin interns"). This helped to ensure consistent data quality between intervention and control facilities; this was necessary to ensure changes we observed were due to an impact on HIV service delivery and not an artefact of improvements in data quality. Intervention facilities each received the minimum package plus the intervention package: 1-2 interns assigned to support programmatic roles, like HIV testing and counseling, patient navigating, and tracing (henceforth called "program interns"). The exact number and roles of interns were determined according to needs and size of the facility.

Site Selection and Randomization

Health facilities were eligible for this study if they were in NMM district, had never received interns from YHA, collaborated with Aurum Institute as a PEPFAR implementing partner, and had a need for three interns (the minimum number of interns that would be placed in a clinic assigned to the intervention group). Twenty eligible facilities were identified and agreed to participate in this study. These facilities were randomized to the control or intervention group at a public randomization event in September 2020 attended by the research team, YHA program staff, facility leaders, and the NMM health district manager. There was no blinding in this study.

Outcomes

The primary outcome in this study was the proportion of people attending the clinic who were tested for HIV (% tested), but we also examined five other HIV service outcomes related to HIV testing, treatment initiation, and retention in care (Table 3.1). To further assess testing, we reviewed the proportion of those

tested who were positive for HIV (% positive). To assess timely linkage to care, we reviewed the proportion of people testing positive who were initiated on treatment within 14 days (% initiated). To assess retention in care, we reviewed the proportion of people on treatment who did not return within 28 days of their scheduled appointment (% early default), the proportion of those on treatment who did not return within 90 days of their scheduled appointment (% late default), and the proportion of those on treatment that had been missing for more than 90 days since their last scheduled appointment (% loss to follow-up).

In addition, we explored whether the YHA program increased testing among young people and males, two groups that are traditionally under-tested. To do this, we examined the proportion of people tested for HIV who were adolescents or young adults (ages 10-29 years old), the proportion of people tested for HIV who were male, and the proportion of people tested for HIV who were male adolescents or young adults.

Data source

Outcome data came from facility-level data that were reported routinely to Aurum Institute from the facility through TIER.Net, South Africa's national HIV surveillance system.

Data analysis

Prior to analysis, we assessed the similarity of facilities in the intervention and control groups at baseline (January – August 2020), comparing facility size, counts of patients served, and proportion of people tested for HIV, positive for HIV, and initiated on treatment descriptively and using two-sample t-tests for unequal variances.

We conducted two sets of analyses using intention-to-treat assignments. The first assessed the cumulative impact of the intervention through a difference-in-difference analysis; this was our primary analysis and was used to examine all outcomes described above. The second assessed impact by examining monthly variation through a controlled, interrupted time series analysis; this was our secondary analysis and was used to further examine HIV service outcomes only. We conducted all analyses in R 3.6.1 (R Core Team 2019, Vienna, Austria).

Analysis 1: We conducted difference-in-difference analyses using linear models to measure the difference in outcomes for the intervention group as compared to the control group from a baseline period (January-August 2020) to study period (January-August 2021). For these analyses, we designated the first three months of this intervention (October-December 2020) as a "run-in" period, hypothesizing it would take interns time to adjust to new roles and impact change; we excluded the run-in period from the analysis. We selected the baseline period to mirror the study period in calendar time. Testing and treatment outcomes were aggregated across the eight-month baseline and study periods (e.g., % tested for HIV = total tested for HIV over 8 months / total headcount for 8 months). The denominator used to calculate retention outcomes could not be aggregated by month, so monthly means were calculated for the default and loss to follow-up outcomes for baseline and study periods.

Models for each outcome were as follows, with 'Time' representing the period (baseline or study), 'Treat' representing the treatment group (control or intervention), and 'DID' calculated as Time*Treat:

$$Y = \beta_0 + \beta_1 Time + \beta_2 Treat + \beta_3 DID$$

We were interested in β_3, which measured the difference in change between the baseline and study period for the intervention versus the control group (difference-in-difference). We tested the null hypothesis that there was no difference in change between the intervention and the control groups ($\beta_3=0$), which we assessed at the 0.05 significance level. We ran these models using the "stats" package in R.

Analysis 2: We conducted controlled, interrupted time series analyses for HIV service outcomes using segmented linear regression models to assess differences in monthly proportions and trends between the intervention and control groups over time. For these models, we used data from a longer time period than the difference-in-difference analysis to establish trends; we included one-year pre-intervention (October 2019-September 2020) and the full intervention period (October 2020-August 2021). Time was measured in calendar months.

Models for each outcome were as follows, with 'Time' representing the number of months since the start of the baseline period, 'Intervention' representing the period (pre-intervention or intervention),

'TimeAfterIntervention' representing the number of months since the placement of the first interns (i.e., months since October 2020), and 'Treat' representing the treatment group (control or intervention).

$$Y_{ijt} = \beta_0 + \beta_1 Time_{ijt} + \beta_2 Intervention_{ijt} + \beta_3 TimeAfterIntervention_{ijt} + \beta_4 Treat_{ijt} + B_5 Treat*Time_{ijt} + \beta_6 Treat*Intervention_{ijt} + \beta_7 Treat*TimeAfterIntervention_{ijt} + E_{ij}$$

We were interested in the magnitude and significance of β_6, which measured the difference-in-difference for immediate change (i.e., the immediate difference observed after intern placement in the intervention group minus the immediate difference observed in the control groups) and β_7, which measured the difference-in-difference for slope change (i.e., the change in slope after the intervention was implemented for the intervention group minus the change in slope observed in the control group). For each outcome, we tested the null hypotheses that there was no difference in immediate change between groups ($\beta_6=0$) or difference in trends between groups ($\beta_7=0$), which we assessed at the 0.05 significance level. We ran these models using the "nlme" package in R (19), using restricted maximum likelihood estimates (REML) and adjusting for autocorrelation (AR1) and clustering at the facility level. We fit all models with random slopes and intercepts.

Sensitivity Analysis

In a sensitivity analysis, we conducted the above-mentioned analyses using as-treated assignments, comparing control facilities to 'high' intervention facilities and 'low' intervention facilities. In the as-treated analysis, facilities were designated as controls if they never had program interns and had admin interns for at least three-quarters of the study period (six months). Facilities were classified as 'high' intervention if they had both admin and program interns simultaneously placed for at least three-quarters of the study period. They were classified as a 'low' intervention if they had admin and program interns simultaneously placed, but for less than three-quarters of the study period. Facilities were excluded from the analysis if they did not meet one of these definitions.

Study Power

This study had 80% power to detect a minimum of 35% change for HIV testing (the primary outcome) if the intraclass correlation was 0.01 (i.e., change from 18.4% people tested to 24.5% of people tested), or a minimum of 82% change if the intraclass correlation was 0.05 (i.e., change from 18.4% of people tested

to 33.4% of people tested); these calculations assumed a 5% level of significance. Power was calculated using baseline HIV testing data for all included clinics.

Ethics

This study was approved by the University of Witwatersrand (Johannesburg, South Africa) human research ethics committee and the provincial ethics committee. Facilities that were in the control group were eligible to receive additional interns, including programmatic interns, after the completion of this study.

RESULTS

Baseline Characteristics

There were substantial differences among facilities in the control and intervention groups at baseline (Table 3.2). The intervention group included larger facilities than the control group and had higher mean counts and proportions for key indicators, but these differences were not statistically significant. Similar differences persisted at baseline in the as treated analysis.

Intervention Adherence

Fifty interns were placed across twenty facilities in October 2020 (17 in control facilities, 33 in intervention facilities), and 34 interns remained at 18 facilities as of August 2021 (12 in control facilities, 22 in intervention facilities) (Appendix A). Among intervention facilities, six facilities had at least one admin intern and one program intern placed simultaneously through August 2021 (high intervention); four facilities had one admin and one program intern placed simultaneously less than half of the time (low intervention). Amongst control facilities, five had a minimum of one admin intern (and no program interns) for at least three-quarters of the study period. The other five facilities designated as controls did not meet the *a priori* definition of a control: two facilities dropped out at the start of the study, two had only program interns for more than half of the study, and one had admin and program interns placed simultaneously for a month (low intervention).

Cumulative Impact

There were no significant changes for outcomes when comparing intervention facilities to control facilities (Table 3.3). Intervention facilities did experience a greater increase in HIV testing than control facilities

(Δ11.7% versus Δ6.5%, respectively), but this difference was not statistically significant (ΔΔ5.2%, p=0.29). Similarly, there was a net increase in treatment initiation for intervention facilities as compared to control facilities, but this difference was not statistically significant (ΔΔ10.3%, p=0.59). There was no difference in change experienced between intervention and control groups for the proportion of people testing positive for HIV or any retention outcome. However, there were notable improvements in all retention outcomes for both intervention and control groups; improvement was most pronounced for loss to follow-up, which was reduced upwards of 75% for both the intervention and control groups. There were no differences observed for the proportion of people tested for HIV who were male, youth, or male youth (Table 3.4).

Monthly Variation

For most HIV service outcomes, there were minimal differences in immediate level changes and trends between the intervention and control groups (Figure 3.1). We did observe an immediate increase in HIV testing following intern placement in the intervention group, but none in the control group (Figure 3.1A); the difference between groups was statistically significant (β_6=10.1% [95% CI: 1.5–18.7%], p=0.02). After this initial jump, the trend for HIV testing remained level for the intervention group, while it gradually increased for the control group; however, the difference in change in trend between groups was not significant (β_7= -0.4% [-1.8%–1.0%], p=0.56). We also observed a steady decrease in treatment initiation for the control group after interns were placed while there was no change in trend for the intervention group, but the difference in change in trend between groups was not significant (β_7= 0.7% [-3.2–4.6%], p=0.73) (Figure 3.1C). There were no noteworthy differences in identification of positive cases, early default, late default, or loss to follow-up between the control and intervention groups. Full model results can be found in Appendix B.

Sensitivity Analysis

The as treated analysis yielded similar results to the intention to treat analysis. However, the impact on HIV testing and treatment initiation was amplified when comparing high-intervention facilities to control facilities (Appendix C). There was a greater difference in HIV testing between the high intervention and control facilities than observed in the intention to treat analysis (β_6=12.8% [1.6–24.0%], p=0.02), but the

cumulative difference was still insignificant (ΔΔ7.1%, p=0.26). In addition, treatment initiation increased for high intervention facilities, resulting in a greater difference in change in trend between high intervention and control facilities than seen in the intention to treat analysis, but results were not significant (β_7= 4.4% [-0.8-9.7%], p=0.10). Differences that had been observed in the intention to treat analysis were more minor or disappeared when comparing low intervention facilities to control facilities (Appendix D).

DISCUSSION

The addition of program interns to health facilities had little impact on facility-based HIV service delivery in this cluster randomized trial. This was largely a null trial, except for a significant increase observed in HIV testing immediately following placement of program interns. However, there were signals for positive impact on HIV testing and treatment initiation that were further amplified in the as treated analysis. We observed no differences between control and intervention facilities in identifying HIV positive cases or retention in care. The addition of program interns to facilities also made no measurable difference in HIV testing rates for males, youth, or male youth.

At first glance, our largely null findings contradict our previous research of the YHA program, where an interrupted time series (ITS) analysis found the YHA program to be associated with significant increases in HIV testing and treatment initiation and significant reductions in loss to follow-up (12) (Table 3.5). We hypothesize that these differences may have existed for four reasons that primarily stem from differences in the two studies (Table 3.6). Firstly, the trial was powered to assess change in HIV testing, but it was powered to detect a larger difference than we observed; the study was not powered to assess differences in other outcomes. As a result, the positive signals we found for HIV testing and treatment initiation may have been significant if our study had more power. Meanwhile, an ITS analysis is not ‘powered’ in the same way as a cluster randomized trial, but it included many more facilities than the trial that would make it easier to detect significant differences in outcomes.

Secondly, we hypothesize that the YHA program may be impactful, but in circumstances that were different than how it was implemented in the trial. The ITS included twenty-times more facilities than the intervention arm of the trial from numerous districts in which the intervention was implemented in a wide

variety of manners (e.g., number and types of interns). The ITS analysis did not find change after the intervention in all facilities; generally, it found the largest difference in outcomes to occur among facilities with five or more interns and no differences in facilities with 1 or 2 interns. We hypothesize that the conditions of the trial—the location and size of facilities and the number of facilities placed—may not have been as conducive for change as the wider variety of conditions that existed in the ITS. For example, the intern dose used in the trial, where half of intervention facilities ended with only two interns, may have been insufficient to influence measurable change.

Thirdly, some of the differences that were observed in the ITS analysis could have been due to differences in data quality, not program change. The trial measured the marginal impact of program interns (in addition to one or more administrative interns), whereas the ITS measured the impact of the full YHA program (program and admin interns). It is possible that we saw less impact than the ITS because it observed changes due to improvements in data quality and not just service delivery, especially for retention in care indicators (12,20). However, healthcare workers working with YHA interns have suggested admin interns are critical in improving facility operations that could be causally linked to changes in HIV service delivery (13). As we used admin interns as controls in our study, we may have muted the observable impact of the YHA program, specifically for retention in care outcomes, (i.e., the admin interns in both control and intervention facilities may have contributed to reductions observed for default and loss to follow-up).

Finally, differences in results between the ITS and the trial may have been due to COVID-19. The trial was implemented during the COVID-19 pandemic, while the ITS analysis reviewed data prior to this pandemic. COVID-19 could have impacted the presence of YHA interns in facilities. While YHA interns are essential personnel and were exempt from lockdowns, they were required to quarantine at home for up to two weeks if exposed to COVID-19, which was not an uncommon occurrence during the trial. There was also greater attrition than normal among the YHA interns in the trial, which could have been due to the stressors of COVID-19. Finally, COVID-19 expanded the tasks that YHA program interns played at facilities during the trial. While their primary role was to support HIV programs, we know that they were also pulled into supporting COVID-19 related activities, such as COVID-19 testing. This may have diluted

the time that program interns in the trial spent on traditional HIV program activities, in comparison to how time was spent by interns in the pre-COVID era.

In reviewing the differences observed between the trial and the ITS, we believe the trial results likely underestimated the impact of YHA on HIV service delivery. However, the trial's largely null findings are not necessarily surprising when reviewing the broader LHW literature. The most definitive impact of LHWs on HIV programs has been seen in HIV testing (21–24), a result we observed to a small degree in this study. LHW programs have not always been found to impact health service delivery or patient outcomes, but this does not necessarily mean they had no impact on the health facility (4,5,25–27). For example, a cluster randomized trial in South Africa found LHWs had no impact on patient outcomes but did positively affect the process of providing care (27). A primary goal of LHW programs is to offload work from healthcare workers (3), which may mean the impact of LHWs is not always tangible (25,28). Even if the YHA approach does not appear to impact HIV services, it could still be effective, as HCWs have described the program to reduce their workloads, improve facility operations, and benefit patient care (13). However, we do believe that this intervention may have impacted aspects of HIV service delivery, as we observed greater change in HIV testing and treatment initiation in facilities that had the intervention in place for longer. Study limitations, including challenges with intern retention and intervention adherence, may have muted this observable impact.

Limitations

This study was subject to many limitations. Firstly, this study included a small number of facilities. While a larger sample size was envisioned, additional sites were not available for randomization when the study was launched, due to delays from the COVID pandemic. The small number of facilities in this study resulted in this study being underpowered for the change observed in HIV testing; moreover, this study was not powered for the other outcomes we assessed. Secondly, this study was implemented during the COVID pandemic, which impacted health facilities and patients in South Africa. While interns were considered essential personnel during lockdowns, they quarantined if sick or exposed to COVID, which contributed to missed workdays and could have limited the overall work the interns were able to perform, and thus reduce the impact we could expect to see in this study. Thirdly, we relied on programmatic data

for this analysis. While measures are in place to ensure data quality, we were not able to verify the accuracy of data used in this study. Reliance on programmatic data also limited what outcomes we could consider in this analysis; the YHA program could have impacted service delivery in ways that were not be measured by available programmatic indicators (13).

Finally, this study was implemented in the context of an ongoing program. This resulted in the study being conducted in a district that had a high proportion of people knowing their HIV status and high PEPFAR investment (17,18). This could limit how much impact this program could have at these health facilities; perhaps if the YHA program were evaluated in districts where facilities had greater room for improvement, we may have observed greater impact. Similarly, the pragmatic nature of this trial meant there was little control over the intervention once implemented. There were frequent changes in intern numbers and roles that were outside the control of the research team, which led to four of the ten intervention facilities having the intervention in place for no more than three months. Differences observed in the as treated analysis suggests the lack of time these facilities spent with the full intervention reduced the impact observed in the study. There was also high intern attrition, possibly because of COVID, leading to lower numbers of interns per facility than anticipated. We believe this attrition also negated impact of the intervention, as past research has found that impact is more likely observed when higher numbers of interns are present; negligible impact has been observed with 1-2 interns per facility, as was generally the case in this study (12). Overall, this study reveals the limitations of implementing randomized trials as part of ongoing programs and highlights the comparative strengths of using quasi-experimental designs to assess impact of programs as implemented.

CONCLUSION

This pragmatic cluster randomized trial found program interns from the YHA program to have little impact on HIV service delivery at facilities in South Africa. There were significant, immediate increases in HIV testing observed after program interns started in facilities, but there were no significant impacts observed for finding HIV positive cases, treatment initiation, retention in care, or testing among males or youth. While this was largely a null trial, we do not believe this suggests the YHA program has no impact on health facilities. Rather, when we review these results along with our previous research (Chapter 2), we

believe study limitations, specifically intervention adherence, could have muted or negated impact we observed. Our previous research suggests YHA may impact HIV service delivery indicators if there are a high enough number of interns at the facility, which we may not have achieved in this study. Moving forward, there is a need to further elucidate the circumstances under which the YHA program provides its greatest impact and to reassess the indicators that should be used to measure the program's impact on the health facility.

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TABLES

Table 3.1. HIV service outcomes and their definitions

Outcome	Calculation	Numerator	Denominator
Testing			
% Tested*	HTS_TST / Headcount	Number tested for HIV	Total headcount
% Positive	HTS_POS/ HTS_TST	Number testing positive for HIV	Number tested for HIV
Treatment			
% Initiated in 14 days	INITIATED_14DAYS / HTS_POS	Number initiating treatment within 14 days of diagnosis	Number testing positive for HIV
Retention			
% Early Default	ART_DEFAULT_EARLY / TX_CURR90	Number who did not return for treatment within 28 days of appointment	Number on treatment
% Late Default	ART_DEFAULT_LATE / TX_CURR90	Number who did not return for treatment within 89 days of appointment	Number on treatment
% Loss to Follow-Up	ART_DEFAULT_ULTF / TX_CURR90	Number of patients out of care for ≥90 days with no outcome (i.e., on the unconfirmed lost to follow-up list)	Number on treatment

*Primary outcome for which the study was powered

Table 3.2. Facility characteristics at baseline (January – August 2020)

	Control (N=10)	Intervention (N=10)	Total (N=20)	p-value*
Facility Type: n (%)				
Clinic	7 (70%)	5 (50%)	12 (60%)	
CHC	1 (10%)	4 (40%)	5 (25%)	NA
Hospital	2 (20%)	1 (10%)	3 (15%)	
Counts of HIV services: mean (sd)				
Headcount	10,711 (3,816)	13,854 (5,652)	12,282 (4,963)	0.16
Tested for HIV	1,815 (1,496)	2,965 (1,867)	2,390 (1,748)	0.15
Positive for HIV	48.2 (37.3)	71.8 (48.8)	60.0 (44.0)	0.24
Initiated in 14 days	27.1 (37.4)	47.2 (46.5)	37.2 (42.4)	0.30
Loss to follow-up	13.2 (14.4)	34.1 (36.8)	23.7 (29.2)	0.11
HIV service outcomes: mean (sd)				
Ratio Tested	0.159 (0.075)	0.209 (0.069)	0.184 (0.075)	0.14
Ratio Positive	0.029 (0.011)	0.024 (0.004)	0.026 (0.009)	0.29
Ratio Linked 14 days	0.461 (0.333)	0.590 (0.268)	0.526 (0.302)	0.35

*Statistical differences calculated using two-sample t-tests for unequal variances
Sd = Standard deviation

Table 3.3. Comparison of change in HIV service indicators between control and intervention facilities after implementation of Youth Health Africa (*Difference-in-difference analysis*). The baseline period baseline period was January-August 2020. The study period was January-August 2021.

	CONTROL (n=10) % (95% CI)			INTERVENTION (n=10) % (95% CI)			Difference-in-Difference % (95% CI)	P-value
	Baseline	**Study**	**Difference**	**Baseline**	**Study**	**Difference**		
% Tested for HIV*	15.9% (11.1–20.6%)	22.4% (10.7–34.1%)	6.5% (-0.4–13.4%)	20.9% (9.4–32.4%)	32.6% (4.5–60.8%)	11.7% (-5.0–28.4%)	**5.2% (-4.6–15.0%)**	0.29
% Positive for HIV	2.9% (2.3–3.4%)	2.3% (0.9, 3.7%)	-0.5% (-1.3, 0.3%)	2.4% (1.0–3.8%)	1.8% (-1.6–5.2%)	-0.6% (-2.5–1.4%)	**-0.05% (-1.2–1.1%)**	0.94
% Initiated on Txt within 14 days	46.1% (27.1–65.2%)	35.2% (-10.8–81.3%)	-10.9% (-37.9–16.1%)	59.0% (12.9–105.1%)	58.4% (-52.8-170%)	-0.6% (-65.7–64.6%)	**10.3% (-27.8–48.5%)**	0.59
% Early Default	10.4% (8.4–12.5%)	10.1% (5.2–15.1%)	-0.3% (-3.2–2.6%)	9.4% (4.5–14.4%)	9.0% (-2.9–21.0%)	-0.4% (-7.4–6.6%)	**-0.1% (-4.2–4.0%)**	0.94
% Late Default	5.7% (4.2–7.2%)	4.4% (0.8–8.0%)	-1.3% (-3.4–0.8%)	5.6% (2.0–9.2%)	4.3% (-4.4–13.0%)	-1.3% (-6.4–3.8%)	**0.0% (-3.0–3.0%)**	0.99
% Loss to Follow-up	9.9% (8.6–11.3%)	2.6% (-0.7–5.8%)	-7.4% (-9.3– -5.4%)	9.6% (6.3–12.9%)	1.5% (-6.4–9.4%)	-8.1% (-12.7– -3.5%)	**-0.7% (-3.5–2.0%)**	0.59

*Primary outcome for which the study was powered

Table 3.4. Comparison of change in HIV testing among males and adolescents/young adults* between control and intervention facilities after implementation of Youth Health Africa. The baseline period baseline period was January-August 2020. The study period was January-August 2021.

Proportion tested for HIV identifying as:	CONTROL (n=10) % (95% CI)			INTERVENTION (n=10) % (95% CI)			Difference-in-Difference % (95% CI)	p-value
	Baseline	Study	Difference	Baseline	Study	Difference		
Male	32.5% (28.4–36.7%)	31.5% (21.6–41.5%)	-1.0% (-6.8–4.8%)	31.9% (22.0–41.9%)	30.6% (6.6–54.6%)	-1.3% (-15.4–12.7%)	**-0.3% (-8.6–7.9%)**	0.94
Adolescents or Young Adult	47.4% (42.6–52.1%)	47.2% (35.8–58.7%)	-0.1% (-6.8–6.6%)	48.9% (37.4–60.3%)	49.3% (21.7–76.9%)	0.4% (-15.8–16.6%)	**0.5% (-8.9–10.0%)**	0.91
Male Adolescents or Young Adult	12.0% (10.3–13.8%)	11.5% (7.3–15.8%)	-0.5% (-3.0–2.0%)	12.2% (8.0–16.5%)	12.0% (1.7–22.2%)	-0.2% (-6.2–5.8%)	**0.3% (-3.3–3.8%)**	0.89

* Adolescents and young adults included ages 10-29 years old.

Table 3.5. Comparison of results between the interrupted time series analysis (Chapter 2) and the cluster randomized trial.

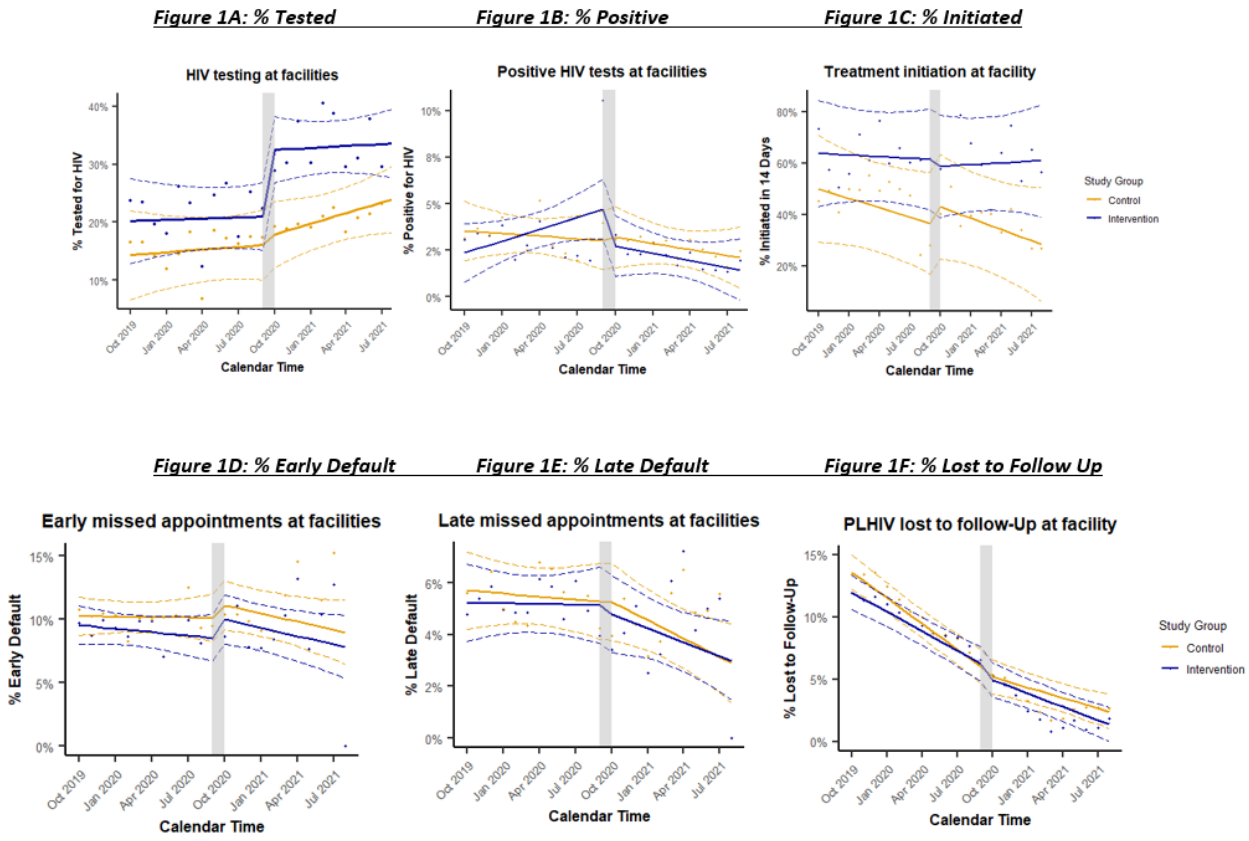
	Time Series	Trial
Testing	Positive change	Initial positive increase Overall, null (but positive signal for change)
Testing Positive	Null	Null
Treatment Initiation	Positive change	Null (but positive signal for change)
Retention in Care	Positive change	Null

Table 3.6. Comparison in study design between the interrupted time series analysis (Chapter 2) and the cluster randomized trial.

	Interrupted Time Series	Cluster Randomized Trial
Timing	Pre-COVID (Oct 2017 – March 2020)	COVID (Interns placed October 2020-Aug 2021)
Number Facilities	207	20 (10 intervention, 10 control)
Number Interns	604	50 placed
Facility Eligibility	▪ Aurum-affiliated ▪ North West or Gauteng province ▪ Interns started Nov 2018-Oct 2019	▪ Aurum-affiliated ▪ NMM district, North West ▪ Never had interns previously
Intern roles & numbers	**Varied** ▪ Range: 1-18 interns / facility ▪ Averages: 5 in Gauteng, 2 in North West	**Standardized** ▪ Control: 1-2 admin interns ▪ Intervention: 1-2 admin interns + 1-2 program interns

FIGURES

Figure 3.1. Monthly reported outcomes from intervention and control facilities, **interrupted by intern placement in facilities in October 2020**. Points are average outcomes per month. Solid lines represent the linear model (yellow=control, blue=intervention). Dotted lines represent the 95% confidence intervals. The grey bar indicates the start of the intervention period.



APPENDIX A: Trial monitoring data

Table 3A.1: Number of Interns placed and retained in facilities during study period: January - August 2021. ***Continued on next page.***

Facility	Intern Role	Placed	Retained during Study Period								Total Months with Interns
		Oct '20	Jan '21	Feb '21	Mar '21	Apr '21	May '21	Jun '21	Jul '21	Aug '21	
CONTROL CLINICS											
Facility 1	Admin	2	2	2	2	2	2	2	2	2	8
	Program	0	0	0	0	0	0	0	0	0	0
Facility 2	Admin	2	2	2	2	2	2	2	2	1	8
	Program	0	0	0	0	0	0	0	0	0	0
Facility 3	Admin	2	2	2	2	2	2	2	2	2	8
	Program	0	0	0	0	0	0	0	0	0	0
Facility 4	Admin	1	1	1	1	1	0	0	1	1	6
	Program	0	0	0	0	0	0	0	0	0	0
Facility 5	Admin	2	2	2	2	2	2	2	2	2	8
	Program	0	0	0	0	0	0	0	0	0	0
Facility 6	Admin	2	0	0	0	0	0	0	0	0	0
	Program	0	0	0	0	0	0	0	0	0	0
Facility 7	Admin	2	1	0	0	0	0	0	0	0	1
	Program	0	0	0	0	0	0	0	0	0	0
Facility 8	Admin	1	2	0	0	0	0	0	0	0	1
	Program	0	0	1	1	1	1	1	1	1	7
Facility 9	Admin	1	1	0	0	0	0	0	0	0	1
	Program	0	0	1	1	1	1	0	0	0	4
Facility 10	Admin	2	1	2	2	2	1	1	1	2	8
	Program	0	0	0	0	0	0	0	0	1	1
	Admin	17	14	11	11	11	9	9	10	10	
	Program	0	0	2	2	2	2	1	1	2	
All Control Interns		**17**	**14**	**13**	**13**	**13**	**11**	**10**	**11**	**12**	

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Facility	Intern Role	Oct '20	Jan '21	Feb '21	Mar '21	Apr '21	May '21	Jun '21	Jul '21	Aug '21	Total Months with Interns
INTERVENTION CLINICS											
Facility 11	Admin	1	1	1	1	1	1	1	1	1	8
	Program	2	2	2	2	2	2	2	2	2	8
Facility 12	Admin	2	2	1	1	1	1	1	1	2	8
	Program	2	2	2	2	2	1	1	1	2	8
Facility 13	Admin	1	2	2	2	2	2	2	2	0	7
	Program	1	2	3	3	3	3	3	3	1	8
Facility 14	Admin	1	1	0	0	0	0	0	0	1	2
	Program	2	1	1	1	1	1	1	1	1	8
Facility 15	Admin	2	1	0	0	0	0	0	0	0	1
	Program	2	2	2	2	2	2	2	2	1	8
Facility 16	Admin	1	1	2	2	2	2	2	2	2	8
	Program	2	2	1	1	1	1	1	1	1	8
Facility 17	Admin	2	2	1	1	1	1	1	1	1	8
	Program	2	2	2	2	2	2	2	2	2	8
Facility 18	Admin	1	1	2	2	2	2	2	2	1	8
	Program	2	2	2	2	2	2	2	2	2	8
Facility 19	Admin	2	0	1	1	1	1	1	1	1	7
	Program	2	2	1	0	0	0	1	1	0	4
Facility 20	Admin	1	1	1	1	1	0	1	1	1	7
	Program	2	1	0	0	0	1	0	0	0	2
TOTAL	**Admin**	**14**	**12**	**11**	**11**	**11**	**10**	**11**	**11**	**10**	
	Program	**19**	**18**	**16**	**15**	**15**	**15**	**15**	**15**	**12**	
All Intervention Interns		**33**	**30**	**27**	**26**	**26**	**25**	**26**	**26**	**22**	
TOTAL (Control and Intervention)		**50**	**44**	**40**	**39**	**39**	**36**	**36**	**37**	**34**	

*Interns occasionally temporarily left facilities for personal reasons (e.g., maternity leave, sickness) and restarted later in the program

Table 3A.2: Number and proportion of months that facilities had interns during study period (Jan – Aug 2021) and the corresponding "as treated" assignment per facility.

		Number Months				% of Months				
Facility	**ITT Group**	**Only A**	**P&A at same time**	**Only P**	**No interns**	**Only A**	**P&A at same time**	**Only P**	**No interns**	**As Treated Analysis**
Facility 1	Con	8	0	0	0	100%	0%	0%	0%	Control
Facility 2	Con	8	0	0	0	100%	0%	0%	0%	Control
Facility 3	Con	8	0	0	0	100%	0%	0%	0%	Control
Facility 4	Con	6	0	0	2	75%	0%	0%	25%	Control
Facility 5	Con	8	0	0	0	100%	0%	0%	0%	Control
Facility 6	Con	0	0	0	8	0%	0%	0%	100%	Exclude
Facility 7	Con	1	0	0	7	13%	0%	0%	88%	Exclude
Facility 8	Con	1	0	7	0	13%	0%	88%	0%	Exclude
Facility 9	Con	1	0	4	3	13%	0%	50%	38%	Exclude
Facility 10	Con	7	1	0	0	88%	13%	0%	0%	Low
Facility 11	Int	0	8	0	0	0%	100%	0%	0%	High
Facility 12	Int	0	8	0	0	0%	100%	0%	0%	High
Facility 13	Int	0	7	1	0	0%	88%	13%	0%	High
Facility 14	Int	0	2	6	0	0%	25%	75%	0%	Low
Facility 15	Int	0	1	7	0	0%	13%	88%	0%	Low
Facility 16	Int	0	8	0	0	0%	100%	0%	0%	High
Facility 17	Int	0	8	0	0	0%	100%	0%	0%	High
Facility 18	Int	0	8	0	0	0%	100%	0%	0%	High
Facility 19	Int	4	3	1	0	50%	38%	13%	0%	Low
Facility 20	Int	6	1	1	0	75%	13%	13%	0%	Low

Con = Control; Int = Intervention; A = Admin intern; P = Program inter

APPENDIX B: Model parameters for time series analyses (Intention to Treat)

Table 3B.1. Model parameters for time series analysis using intention to treat groupings. Model for analysis was: $Y_{ijt} = \beta_0 + \beta_1 Time_{ijt} + \beta_2 Intervention_{ijt} + \beta_3 TimeAfterIntervention_{ijt} + \beta_4 Treat_{ijt} + B_5 Treat*Time_{ijt} + \beta_6 Treat*Intervention_{ijt} + \beta_7 Treat*TimeAfterIntervention_{ijt} + E_{ij}$

	Beta Estimate	Standard Error	95% CI: Lower	95% Upper	Significant (p<0.05)
TESTING					
% Tested					
β_0	14.2%	4.2%	6.0%	22.4%	*NA*
β_1Time	0.2%	0.4%	-0.6%	0.9%	*NA*
β_3TimeAfterIntervention	0.5%	0.5%	-0.5%	1.4%	*NA*
β_2Intervention	1.2%	3.1%	-4.9%	7.4%	*NA*
β_4Treat	6.0%	5.8%	-6.1%	18.1%	*NA*
B_5Treat*Time	-0.1%	0.5%	-1.1%	0.9%	*NA*
β_6Treat*Intervention	**10.1%**	**4.4%**	**1.5%**	**18.7%**	**YES (p=0.02)**
β_7Treat*TimeAfterIntervention	**-0.4%**	**0.7%**	**-1.8%**	**1.0%**	**NO**
% HIV Pos					
β_0	3.6%	0.9%	1.8%	5.4%	*NA*
β_1Time	0.0%	0.1%	-0.3%	0.2%	*NA*
β_3TimeAfterIntervention	-0.1%	0.2%	-0.4%	0.3%	*NA*
β_2Intervention	0.3%	1.2%	-2.1%	2.6%	*NA*
β_4Treat	-1.4%	1.3%	-4.1%	1.3%	*NA*
B_5Treat*Time	0.3%	0.2%	-0.1%	0.6%	*NA*
β_6Treat*Intervention	**-2.1%**	**1.7%**	**-5.4%**	**1.2%**	**NO**
β_7Treat*TimeAfterIntervention	**-0.3%**	**0.3%**	**-0.8%**	**0.2%**	**NO**
INITIATED					
% Initiated within 14 days					
β_0	51.1%	11.2%	29.2%	73.1%	*NA*
β_1Time	-1.2%	1.0%	-3.1%	0.7%	*NA*
β_3TimeAfterIntervention	-0.3%	1.4%	-3.1%	2.6%	*NA*
β_2Intervention	7.8%	8.9%	-9.7%	25.4%	*NA*
β_4Treat	12.9%	15.7%	-20.2%	45.9%	*NA*
B_5Treat*Time	1.0%	1.4%	-1.7%	3.7%	*NA*
β_6Treat*Intervention	**-10.8%**	**12.4%**	**-35.2%**	**13.5%**	**NO**
β_7Treat*TimeAfterIntervention	**0.7%**	**2.0%**	**-3.2%**	**4.6%**	**NO**

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Table 3B.1 continued

	Beta Estimate	Standard Error	95% CI: Lower	95% Upper	Significant (p<0.05)
RETAINED					
% Early Default (28 days)					
β_0	10.2%	0.8%	8.6%	11.9%	*NA*
β_1Time	0.0%	0.1%	-0.2%	0.2%	*NA*
β_3TimeAfterIntervention	-0.2%	0.2%	-0.5%	0.1%	*NA*
β_2Intervention	1.2%	1.0%	-0.8%	3.2%	*NA*
β_4Treat	-0.6%	1.2%	-3.1%	1.9%	*NA*
B_5Treat*Time	-0.1%	0.2%	-0.4%	0.2%	*NA*
β_6Treat*Intervention	**0.5%**	**1.4%**	**-2.4%**	**3.3%**	**NO**
β_7Treat*TimeAfterIntervention	**0.1%**	**0.2%**	**-0.4%**	**0.5%**	**NO**
% Late Default (90 days)					
β_0	5.7%	0.8%	4.1%	7.4%	*NA*
β_1Time	0.0%	0.1%	-0.2%	0.1%	*NA*
β_3TimeAfterIntervention	-0.2%	0.2%	-0.5%	0.1%	*NA*
β_2Intervention	0.2%	0.8%	-1.3%	1.7%	*NA*
β_4Treat	-0.5%	1.2%	-3.0%	2.0%	*NA*
B_5Treat*Time	0.0%	0.1%	-0.2%	0.3%	*NA*
β_6Treat*Intervention	**-0.4%**	**1.1%**	**-2.5%**	**1.8%**	**NO**
β_7Treat*TimeAfterIntervention	**0.0%**	**0.2%**	**-0.4%**	**0.5%**	**NO**
% ULTFU					
β_0	14.3%	0.8%	12.8%	15.7%	*NA*
β_1Time	-0.7%	0.1%	-0.8%	-0.5%	*NA*
β_3TimeAfterIntervention	0.4%	0.1%	0.2%	0.7%	*NA*
β_2Intervention	-0.6%	0.3%	-1.2%	0.1%	*NA*
β_4Treat	-1.8%	1.1%	-4.0%	0.4%	*NA*
B_5Treat*Time	0.2%	0.1%	0.0%	0.4%	*NA*
β_6Treat*Intervention	**-0.4%**	**0.5%**	**-1.3%**	**0.5%**	**NO**
β_7Treat*TimeAfterIntervention	**-0.2%**	**0.2%**	**-0.6%**	**0.1%**	**NO**

APPENDIX C. As Treated Results (High Intervention vs Control facilities)

Table 3C.1. Comparison of change in HIV service indicators between control and high intervention facilities after implementation of Youth Health Africa (*Difference-in-Difference analysis*). The baseline period baseline period was January-August 2020. The study period was January-August 2021.

	CONTROL (n=5) % (95% CI)			HIGH INTERVENTION (n=6) % (95% CI)			Difference-in-Difference % (95% CI)	P-value
	Baseline	**Study**	**Difference**	**Baseline**	**Study**	**Difference**		
% Tested for HIV*	16.5% (9.8–23.2%)	21.9% (5.8–38.0%)	5.4% (-4.0–14.8%)	22.9% (7.3–38.6%)	35.4% (-2.7–73.6%)	12.5% (-10.0–35.0%)	7.1% (-5.9–20.2%)	0.26
% Positive for HIV	3.0% (2.1–3.8%)	2.2% (0.2% - 4.1%)	-0.8% (-1.9–0.4%)	2.3% (0.4–4.2%)	1.7% (-2.9–6.4%)	-0.6% (-3.3–2.1%)	0.2% (-1.4%, 1.8%)	0.81
% Initiated on Txt within 14 days	47.6% (15.3–79.9%)	46.0% (-31.9–124%)	-1.5% (-47.2–44.1%)	58.9% (-17.0–135%)	68.3% (-115–252%)	9.4% (-98.1–117%)	10.9% (-50.9–72.7%)	0.72
% Early Default	10.2% (6.8–13.7%)	9.3% (0.9–17.6%)	-0.9% (-5.8–4.0%)	9.4% (1.2–17.5%)	9.2% (-10.4–28.9%)	-0.1% (-11.6–11.4%)	0.8% (-5.8–7.4%)	0.80
% Late Default	5.6% (3.1–8.1%)	3.9% (-2.1–10.0%)	-1.7% (-5.2–1.9%)	5.7% (-0.2–11.7%)	4.5% (-9.8–18.8%)	-1.2% (-9.6–7.1%)	0.4% (-4.4–5.3%)	0.85
% Loss to Follow-up	8.4% (6.6–10.3%)	2.1% (-2.3–6.6%)	-6.3% (-8.9– -3.7%)	9.5% (5.2–13.9%)	1.8% (-8.7–12.3%)	-7.7% (-13.9–-1.5%)	-1.4% (-5.0–2.1%)	0.41

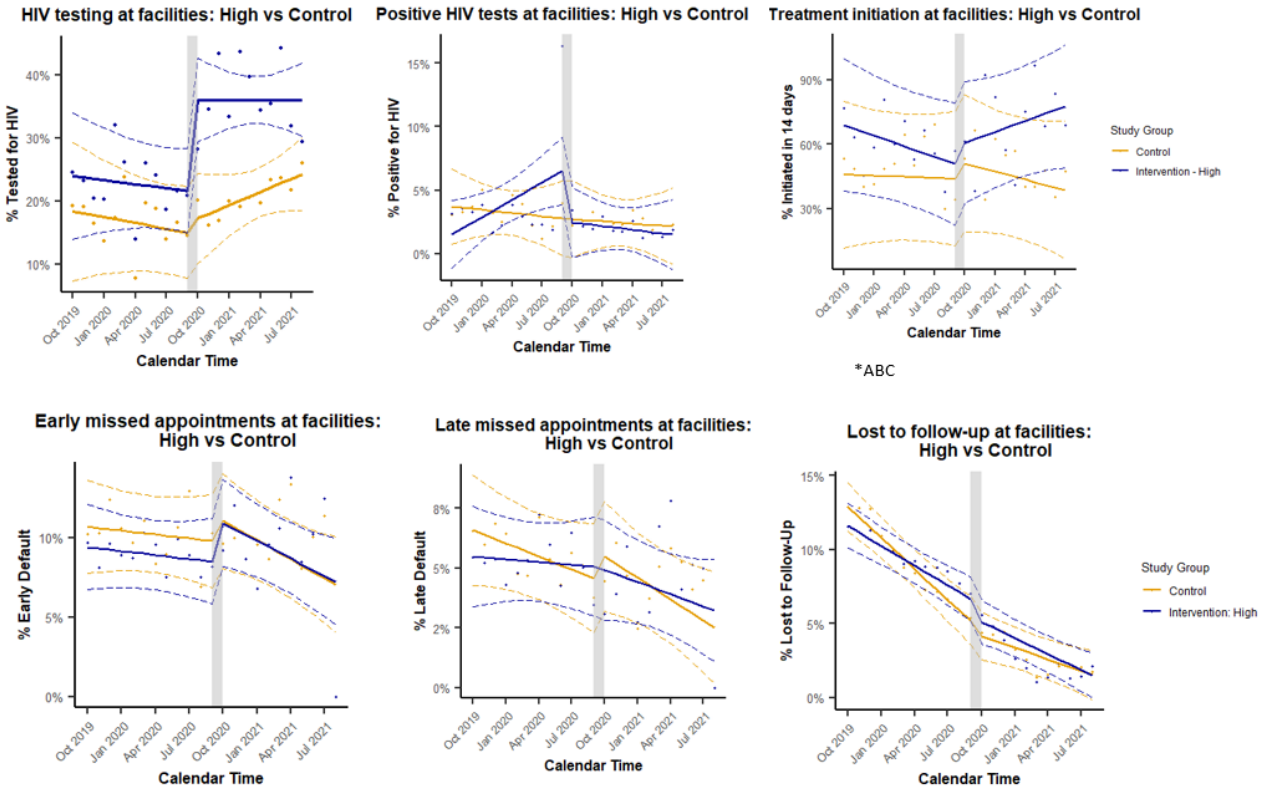
*Primary outcome for which the study was powered

Table 3C.2. Comparison of change in HIV testing among males and adolescents/young adults between control and high intervention facilities after implementation of Youth Health Africa. The baseline period baseline period was January-August 2020. The study period was January-August 2021.

Proportion tested for HIV who identified as:	CONTROL (n=5) % (95% CI)			HIGH INTERVENTION (n=6) % (95% CI)			Difference-in-Difference % (95% CI)	p-value
	Baseline	Study	Difference	Baseline	Study	Difference		
Male	32.3% (28.1–36.6%)	31.4% (21.2–41.7%)	-0.9% (-6.9–5.1%)	31.2% (21.3–41.2%)	30.3% (6.2–54.4%)	-1.0% (-15.1–13.1%)	-0.1% (-8.2–8.0%)	0.98
Adolescents or Young Adult	50.4% (45.0–55.8%)	49.2% (36.1–62.3%)	-1.2% (-8.9–6.5%)	48.9% (36.2–61.7%)	49.2% (18.4–80.1%)	0.3% (-17.8–18.4%)	1.5% (-8.9–11.9%)	0.77
Male Adolescents or Young Adult	13.2% (10.5–15.9%)	12.4% (5.9–18.8%)	-0.8% (-4.6–3.0%)	11.9% (5.6–18.2%)	11.9% (-3.3–27.1%)	0.1% (-8.8–9.0%)	0.9% (-4.3–6.0%)	0.73

*Adolescents and young adults included ages 10-29 years old.

Figure 3C.1. Monthly reported outcomes from high intervention and control facilities, **interrupted by intern placement in facilities in October 2020**. Points are average outcomes per month. Solid lines represent the linear model (yellow=control, blue=intervention). Dotted lines represent the 95% confidence intervals. The grey bar indicates the start of the intervention period.



APPENDIX D: As Treated Results (Low Intervention vs Control facilities)

Table 3D.1. Comparison of change in HIV service indicators between control and low intervention facilities after implementation of Youth Health Africa (*Difference-in-Difference analysis*). The baseline period baseline period was January-August 2020. The study period was January-August 2021.

	CONTROL (n=5) % (95% CI)			LOW INTERVENTION (n=5) % (95% CI)			Difference-in-Difference % (95% CI)	P-value
	Baseline	**Study**	**Difference**	**Baseline**	**Study**	**Difference**		
% Tested for HIV*	16.5% (9.8–23.2%)	21.9% (5.8–38.0%)	5.4% (-4.0–14.8%)	18.7% (1.0–36.4%)	30.5% (-11.8–72.8%)	11.8% (-12.8–36.4%)	6.4% (-8.2–21.0%)	0.36
% Positive for HIV	3.0% (2.1–3.8%)	2.2% (0.2–4.1%)	-0.8% (-1.9–0.4%)	2.4% (0.3–4.6%)	1.7% (-3.4–6.9%)	-0.7% (-3.7–2.3%)	0.1% (-1.7–1.9%)	0.92
% Initiated on Txt within 14 days	47.6% (15.3–79.9%)	46.0% (-31.9–124%)	-1.5% (-47.2–44.1%)	61.2% (-12.1–134%)	42.6% (-134–219%)	-18.6% (-122–85.0%)	-17.1% (-77.8–43.6%)	0.56
% Early Default	10.2% (6.8–13.7%)	9.3% (0.9–17.6%)	-0.9% (-5.8–4.0%)	9.4% (2.5–16.3%)	9.5% (-7.2–26.3%)	0.1% (-9.7–10.0%)	1.1% (-4.7–6.8%)	0.70
% Late Default	5.6% (3.1–8.1%)	3.9% (-2.1–10.0%)	-1.7% (-5.2–1.9%)	5.8% (0.9–10.7%)	5.0% (-6.9–16.9%)	-0.8% (-7.8–6.2%)	0.9% (-3.2–5.0%)	0.65
% Loss to Follow-up	8.4% (6.6–10.3%)	2.1% (-2.3–6.6%)	-6.3% (-8.9– -3.7%)	10.9% (6.0–15.8%)	2.0% (-9.8–13.8%)	-8.9% (-15.8– -1.9%)	-2.6% (-6.6–1.5%)	0.20

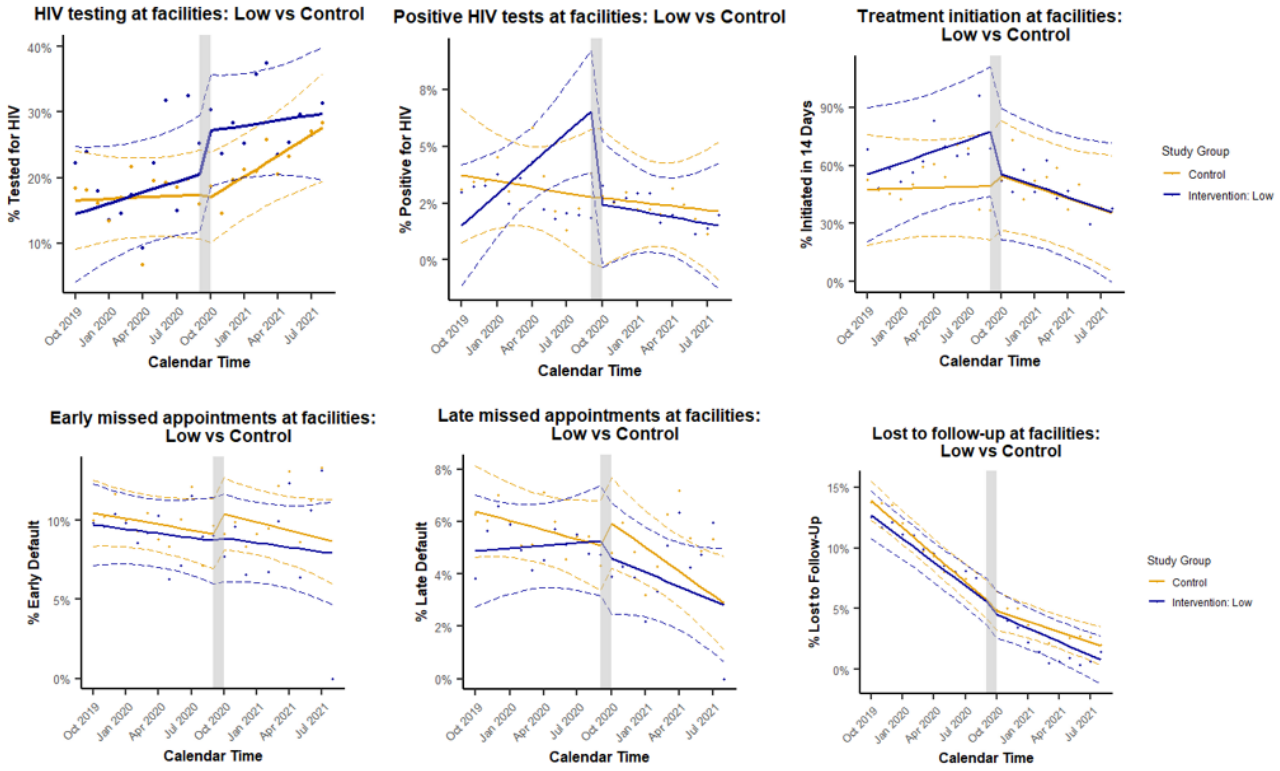
*Primary outcome for which the study was powered

Table 3D.2. Comparison of change in HIV testing among males and adolescents/young adults between control and low intervention facilities after implementation of Youth Health Africa. The baseline period baseline period was January-August 2020. The study period was January-August 2021.

Proportion tested for HIV who identified as:	CONTROL (n=5) % (95% CI)			LOW INTERVENTION (n=6) % (95% CI)			Difference-in-Difference % (95% CI)	p-value
	Baseline	Study	Difference	Baseline	Study	Difference		
Male	32.3% (28.1–36.6%)	31.4% (21.2–41.7%)	-0.9% (-6.9–5.1%)	32.2% (22.9–41.4%)	30.8% (8.5–53.0%)	-1.4% (-14.4–11.6%)	-0.5% (-8.1–7.1%)	0.89
Adolescents or Young Adult	50.4% (45.0–55.8%)	49.2% (36.1–62.3%)	-1.2% (-8.9–6.5%)	47.9% (34.7–61.2%)	46.5% (14.6–78.5%)	-1.4% (-20.1–17.3%)	-0.2% (-11.2–10.7%)	0.97
Male Adolescents or Young Adult	13.2% (10.5–15.9%)	12.4% (5.9–18.8%)	-0.8% (-4.6–3.0%)	12.4% (5.9–19.0%)	11.3% (-4.4–27.0%)	-1.2% (10.4–8.0%)	-0.4% (-5.8–5.0%)	0.88

*Adolescents and young adults included ages 10-29 years old.

Figure 3D.1. Monthly reported outcomes from low intervention and control facilities, interrupted by intern placement in facilities in October 2020. Points are average outcomes per month. Solid lines represent the linear model (yellow=control, blue=intervention). Dotted lines represent the 95% confidence intervals. The grey bar indicates the start of the intervention period.



CHAPTER 4. "They are gaining experience; we are gaining extra hands": A mixed methods study to assess healthcare worker perceptions of a novel strategy to strengthen human resources for HIV in South Africa

Deanna Tollefson[1], Nasiphi Ntombela[2], Sarah Reeves[3], Salome Charalambous[2,4], Gabrielle O'Malley[1], Geoffrey Setswe[2,5], Ann Duerr [1, 6]

1: University of Washington, Department of Global Health, Seattle, United States

2: The Aurum Institute, Implementation Research Division, Parktown, South Africa

3: Youth Health Africa, Parktown, South Africa

4: School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

5: Department of Health Studies, University of South Africa, Pretoria, South Africa

6: Fred Hutchinson Cancer Research, Vaccine and Infectious Disease & Public Health Science Divisions, Seattle, United States

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INTRODUCTION

The global healthcare worker (HCW) shortage disproportionately impacts low- and middle-income countries (LMICs) (1). This has been a particular challenge for the HIV response in LMICs, such as South Africa (2–5). South Africa has the world's largest HIV epidemic (6), which requires sufficient human resources for health to ensure HIV programs can be fully delivered (5,7). Insufficient human resources for health leads to excessive workloads for HCWs, which is known to reduce HCW motivation and lead to attrition (8–10). Use of lay health workers (LHWs), defined as those supporting health work without professional or paraprofessional qualifications, has long been advocated to increase human resources for health (11,12). LHWs are viewed as critical to strengthen human resources for health and improve HIV service delivery (12,13), but many countries, like South Africa, lack sufficient LHWs, thus necessitating novel strategies to support LHWs for HIV work (14,15).

Youth Health Africa (YHA) is a novel LHW approach that places young adults needing work experience in one-year non-clinical internships at health facilities to increase human resources for health and thereby strengthen HIV services. Like traditional LHWs, interns support clinics by task shifting and task sharing, which involves placing lesser-trained staff in health facilities to offload existing tasks from HCWs to reduce their work burden (task sharing) and/or give HCWs time to focus on higher-level tasks (task shifting) (16). However, YHA is different from other LHW programs as it involves young adults working for one year, when typically, LHWs in South Africa are older and have longer assignments (14). Moreover, YHA's primary goal is youth empowerment; it provides interns work experience to increase their future employability and thereby address high youth unemployment (17).

While research suggests YHA may improve facility-based HIV service delivery (18) (see Chapters 2 and 3), HCW perspectives on this program are unknown. Acceptability (how agreeable a program is to stakeholders) and appropriateness (how well a program fits where it is implemented) are critical to successful program implementation (19,20). Factors affecting the acceptability or appropriateness of interventions designed to strengthen human resources for health are not well documented. While HCWs are often appreciative of task shifting and sharing (21), research suggests HCWs can be resistant to LHWs (3,11,20,22). The novelty of the YHA approach means it is difficult to predict how HCWs may

perceive the program. To understand HCW perspectives of whether and how the YHA approach can be used to strengthen human resources for health, we conducted a mixed methods study to [1] describe the acceptability and appropriateness of YHA as implemented from the HCW perspective, and [2] identify factors promoting or hindering high acceptability and perceived appropriateness of the YHA approach. A secondary objective of this research was to understand what, if any, impact the healthcare workers felt this program had on their health facility, which would complement the findings from Chapters 2 and 3.

METHODS

Study Design

We used a convergent mixed methods study design, with an equal emphasis on quantitative and qualitative methods (QUAN + QUAL), to assess HCW perceptions of acceptability and appropriateness of YHA as implemented in South Africa. We defined acceptability as how satisfying or agreeable YHA was to HCWs and appropriateness as how well YHA fit HCW/facility needs (19). We concurrently collected quantitative data through surveys and qualitative data through interviews using a multilevel sample of HCWs. We analyzed data separately, then merged findings for interpretation. We used a mixed methods approach for purposes of complementarity and triangulation, which fostered a more comprehensive and accurate understanding of HCW perceptions than either method would have alone (23).

YHA Program

YHA interns are 18-34 years old with secondary education but no employment experience. Interns support HIV-related programmatic (e.g., HIV testing) and/or administrative roles (e.g., data capture, filing) in facilities in their communities after receiving a 3–5-day training by YHA. YHA collaborates with PEPFAR implementing partners who support clinics to place interns in facilities that need additional human resources for health. YHA pays interns stipends and provides monthly training throughout the year-long internship. Interns work alongside HCWs at the facility and are formally supervised by a HCW who works for the PEPFAR implementing partner. YHA is modeled after internship programs implemented at South African businesses, with private organizations funding internships, incentivized by the country's Broad-Based Black Economic Empowerment policy.

Study Population

The study population comprised HCWs who supervised or worked with YHA interns, which we will refer to as “intern supervisors” and “frontline HCWs.” Intern supervisors were tasked by the PEFPAR implementing partner to provide intermittent supportive supervision to interns and often worked across many facilities. Frontline HCWs were staff who worked alongside interns at the health facility, including nurses who helped lead the facility (facility managers) and individuals who worked directly with the interns on a regular basis (facility colleagues); frontline HCWs had no connection to YHA, whereas intern supervisors shared feedback on interns with YHA on a monthly basis.

We conducted surveys with intern supervisors because they offered a broad perspective on the program, having engaged with multiple interns across many facilities. We interviewed frontline HCWs to gain an in-depth understanding of their experiences working alongside interns and their perception of program benefits.

Setting

While YHA has been implemented across South Africa, this study was conducted among HCWs at facilities in Gauteng and North West (NW) provinces where Aurum Institute is the PEPFAR implementing partner. Surveys covered intern supervisors working at all Aurum-affiliated facilities with YHA in Gauteng and NW. Interviews were conducted in a sample of facilities with YHA from two districts: Ekurhuleni, Gauteng and Ngaka Modiri Molema, NW.

Data Collection

From March-May 2021, we invited all HCWs who supervised interns to complete a self-administered, electronic survey. The survey included mostly close-ended questions: 15 to measure acceptability, 15 to measure appropriateness, and other questions on the supervisor’s role and characteristics and program implementation. The 30 questions on acceptability and appropriateness were adapted from the Johns Hopkins Dissemination and Implementation Science (JHD&I) Measure of Acceptability and Appropriateness (24), which has been validated and used in LMICs (25–28). These questions were answered on a four-point scale (1=“Not at all,” 2=“A little”, 3=“A moderate amount,” or 4=“A lot”). We made minor adaptions to fit the YHA and South African contexts and piloted the survey before use. The

survey was in English and implemented using REDCap electronic data capture tools, which were hosted at the Institute of Translational Health Sciences.

During the same period, we conducted in-person, in-depth interviews with frontline HCWs using a semi-structured interview guide, which included questions on their experience with YHA and the benefits and challenges of the program. Two questions asked about acceptability and appropriateness, pulled from the JHD&I measures (24). Research assistants from the Implementation Research Division at the Aurum Institute conducted the interviews in English or local languages (i.e., Setswana in North West and IsiZulu or Sesotho in Gauteng), based on interviewee preference. Interviews lasted between 30-60 minutes. All interviews were recorded, transcribed and translated into English, as needed.

We selected HCWs for interviews using a two-step process. First, we selected facilities through random sampling, stratifying by geography (NW versus Gauteng) and facility type (clinic versus community health centers [CHCs]/hospitals), as we hypothesized that experience with YHA may vary based on clinic type or location. Five clinics and three CHCs/hospitals were selected from each region. We then used purposive sampling to select the two types of frontline HCWs: at least one facility manager and one facility colleague to interview per facility. At each facility, we selected the facility manager who oversaw the HCWs that the interns supported and a facility colleague who worked closely with YHA interns. Interviews were conducted until we reached saturation.

Quantitative Analysis

We calculated a total and average score for acceptability and appropriateness for each respondent. When responses were missing or categorized as “I don’t know”, we weighted final scores based on existing responses. We then calculated the mean and standard deviation for acceptability and appropriateness in Stata 15 (StataCorp LLC., College Station, TX). We graphically summarized responses for each question comprising the acceptability and appropriateness measures in R 3.6.1 (R Core Team 2019, Vienna, Austria), using *ggplot2* and *HH* packages (29,30); missing responses or those responding “I don’t know” were excluded. Finally, we conducted bivariate logistic regression analyses in R to explore whether intern supervisor characteristics or their roles with the program were associated with acceptability and appropriateness.

Qualitative Analysis

We used Dedoose 9.0.17 (SocioCultural Research Consultants LLC., Los Angeles, CA) to conduct an inductive, thematic analysis. A primary coder (DT) developed a preliminary codebook based on a preliminary review of transcripts. The primary coder and secondary coder (NN) coded three transcripts independently and came to consensus on code applications and an expanded codebook. DT coded all transcripts and further refined the codebook. NN reviewed all coded transcripts and the updated codebook and noted any disagreements. DT and NN came to consensus on all application of codes and collaboratively identified themes that emerged from the interviews.

Integration

We compared quantitative and qualitative findings and interpreted the results together to present a holistic view of acceptability and appropriateness from the HCW perspective. To facilitate integration, we matched survey questions and interview themes to the seven domains of the Theoretical Framework of Acceptability, which was created to facilitate an understanding of what impacts acceptability of healthcare interventions (31).[2] While this framework's definition of acceptability is inclusive of appropriateness, we added a domain, '*facility fit'*, to better fit Proctor's definition of appropriateness. To further support interpretation of our data, we divided this framework's domains into three naturally occurring groups: nature of the intervention, implementation of the intervention, and results of the intervention. The domains of this framework are outlined and defined in Figure 4.1.

Ethics

This study was approved by ethics committees at the University of the Witwatersrand (Johannesburg, South Africa) and the University of Washington (Seattle, USA), along with the provincial and district-level ethics committees where the study was conducted.

[2] Implementation science research commonly uses the Consolidated Framework for Implementation Research (CFIR), but this framework looks at factors related to 'implementation' as the outcome. In this paper, our outcome of interest is acceptability and appropriateness (not implementation), thus we found a framework specific to these outcomes to guide our review of the data.

RESULTS

Participants

Sixty of the 66 eligible intern supervisors completed surveys (91% response rate) (Table 4.1). Altogether, they supervised 364 interns at 180 facilities. Almost half had served as an intern supervisor for at least one year, giving them experience with more than one intern cycle. We also interviewed 33 healthcare workers (16 facility managers, 17 facility colleagues) from 16 facilities (Table 4.2). Over half of the facilities hosted 2-3 interns at the time of the interviews. Almost half of interviewees had worked at their facility for at least three years.

Surveys

Surveys found the YHA intern program to be acceptable and appropriate to intern supervisors. On a four-point scale, the average score for acceptability was 3.5 (standard deviation: 0.4), while the average score for appropriateness was 3.6 (0.4). Fifty-three respondents (89%) had average scores that rated the program at least moderately acceptable (≥3.0), and 57 (95%) had average scores that rated the program at least moderately appropriate (≥3.0) (Figure 4.2). There were no associations with respondent characteristics (gender, profession, years in current position) or their roles with YHA (duration as supervisor, number of interns supervised, number of facilities requiring supervision) and acceptability or appropriateness (Appendix A). Intern supervisors in Gauteng and those supervising only administrative interns had lower perceptions of acceptability and appropriateness, but differences were not significant.

While acceptability and appropriateness measures were highly scored overall, there was a range in positive responses for individual questions (Figure 4.3). For both acceptability and appropriateness measures, ≥95% of respondents agreed with 8 of 15 questions at least “a moderate amount.” For the acceptability measure, top scoring questions were related to the nature of the program and its results. The appropriateness measure questions were related to program results and its general fit with the health facility. For both measures, the lowest scoring questions were related to the clarity and burden of the intervention and competing priorities. Two questions, related to satisfaction with the support provided for supervising interns and program orientation, scored much lower than other questions (Figure 4.3A).

Interviews

Most frontline HCWs reported that YHA was highly acceptable and appropriate. No respondents reported low levels of satisfaction or fit with the program. We observed no differences when comparing acceptability and appropriateness between facility managers versus facility colleagues, clinics versus CHCs/hospitals, and NW versus Gauteng. One nurse's words capture the majority opinion:

> *"There are no disadvantages. I have been singing praises thus far, that they [the interns] have helped us a lot." (NW-14, Clinic)*

We identified four major themes that explained HCW perceptions on acceptability and appropriateness of YHA (Table 4.3).

Theme 1. YHA is mutually beneficial to HCWs and interns

Frontline HCWs expressed strong affinity for YHA because they viewed it to be mutually beneficial, benefiting HCWs by being "extra hands" to do work at facilities and benefiting interns and broader society by providing youth with employment and job training. This theme is a synthesis of two key ideas present in interviews: that interns reduced HCW burdens and that HCWs felt good helping interns.

HCWs strongly emphasized that they were overworked as facilities were understaffed. They reported that interns alleviated some of this burden by offloading some work through task sharing with non-clinical staff and task shifting with nurses.

> *"Knowing that every day there is a person who is going to help with the simple tasks reduces the workload so that we can focus more on the clients." (Gauteng-4, Nurse, Clinic)*

In describing how YHA reduced facility workload, HCWs emphasized the professionalism of the interns. HCWs frequently noted that interns were young and lacked experience, but they described the interns positively (e.g., respectful, hardworking, committed, and amiable). While interns needed initial training and occasional coaching on professionalism, they were ultimately viewed to be competent, independent workers who took initiative to accomplish tasks.

> *"They are able to do everything by themselves, without us asking them, "Did you do this? Did you do that?" They know exactly what to do." (NW-6, Nurse, CHC/Hospital)*.

While HCWs liked the YHA program because it helped them, it was common for HCWs to say the first reason they liked the program was because it benefited the interns. YHA appealed to HCWs' sense of altruism. HCWs described appreciating how YHA provided immediate support to youth (e.g., receiving

wages to support their family), how it empowered youth to have better futures, and how it would better society by improving the skills of South Africa's workforce. Facility colleagues often described liking the program because it provided immediate relief to a youth's challenging economic circumstances, while facility managers, who tended to be older, described finding satisfaction in mentoring youth, as they believed doing so would help to improve the youth's, and society's, future.

> *"I like [YHA] because at least they give these kids a chance of working. You know, some of them are coming... from schools, some of them are mothers, which they don't have a job, they need a job you know." (Gauteng-9, Data capturer, Clinic)*

> *"[YHA] has also given me the satisfaction as a human being….that at least I am contributing to this, to our [youth]…., who will be our future tomorrow." (Gauteng-13, Nurse, CHC/Hospital)*

Theme 2. Facilities need agency when implementing YHA

While HCWs were generally enthusiastic about YHA, many expressed frustration about having little say in, or foreknowledge of, intern placements. HCWs described feeling unprepared for interns and felt interns were sometimes assigned to roles that did not match the facility's needs because HCWs were not part of the planning process.

> *"We only got clerks….Our challenge here is we don't have data capturers…I wish they could have brought more like data capturers and counselors." (NW-3, Nurse, Clinic)*

However, once interns were placed at clinics and HCWs assumed responsibility for the interns, they were able to easily integrate into clinic operations.

> *"They have blended simply, and they have managed to just come to the facility and become part and parcel of us and became like a family." (NW-14, Nurse, Clinic)*

Having this agency promoted the sense that YHA fit the facility, which fostered a high affinity for the program among most HCWs. Facility managers experiencing the poorest communication with YHA were apt to feel they lacked agency in directing the intern's work. Though outliers, these HCWs expressed less satisfaction with the program.

Theme 3: Short internships can be burdensome

HCWs explained that while interns were helpful, the short internship period could be burdensome. HCWs were required to provide interns on-the-job training which was time consuming, specifically for facility colleagues, who worked closest with the interns. Many HCWs were concerned about this upfront investment as interns would be present for only one year. Moreover, HCWs expressed concern that they

had come to depend on interns, who were on time-limited contracts. HCWs frequently described wanting to lengthen the internships or find a way to permanently hire the interns to reduce this burden.

> *"It is difficult when you have people you have trained then they have to go, then you have to start again. And we are not getting any remuneration for that, so it is tiring." (Gauteng-12, Nurse, Clinic)*

Theme 4: Success from YHA is found in more than numbers

While frontline HCWs believed YHA helped them reach HIV targets, they appreciated YHA because it brought success in other ways. HCWs described how interns created a "smoother" working environment, such as improving patient flow by expediting retrieval of patient files. HCWs also described how YHA improved morale, as it reduced workload and ensured staff could step away without worry of interruption to services.

> *"I feel better because I am no longer overloaded with work. Even if I am sick, I know there is a back-up then. The [YHA] data capturer will come and work. Everything will be well. (Gauteng-11, Data Capturer, CHC/Hospital)*

HCWs also believed YHA benefited patient care, especially in terms of improved services for young people. Many HCWs explained their struggles to test young people for HIV, due to limited hours for HIV testing and counseling and large age differences between counselors and adolescents/young adults. HCWs felt YHA interns bridged these gaps, by enabling facilities to provide testing for extended hours with younger counselors.

Integrated Findings

Both intern supervisors and frontline HCWs found the YHA approach to be highly acceptable and appropriate. When we integrated findings from these two groups using the Theoretical Framework of Acceptability (TFA), we saw that intern supervisors and HCWs expressed similar sentiments about the YHA approach (i.e., the quantitative and qualitative findings converged), even though these groups had different roles in the program. This enabled us to identify factors that promoted or hindered acceptability and appropriateness of YHA among HCWs, which we discuss by TFA domain (Table 4.4).

HCWs genuinely liked the program as they found it provided the facilities with much-needed support (TFA domain: *affective attitude*) and they agreed with its higher goal of empowering youth by supporting the internships (*ethicality*). Other factors that promoted acceptability/appropriateness of the program included

HCWs finding it easy to integrate interns into their jobs (*self-efficacy*), the program aligning with facility culture (*facility fit*), and HCW belief that interns helped the facility be more successful (*perceived effectiveness*).

Factors hindering acceptability and appropriateness included having an inadequate introduction to or communication with the program (*intervention coherence*) and the time required to train, and to a lesser extent, supervise interns (*burden)*. We noticed divergence in whether HCWs perceived the *opportunity cost* of YHA interns to promote or hinder acceptability/appropriateness; while the benefits of the YHA program were widely believed to outweigh costs, frontline HCWs worried that this balance could reverse if there was not a plan to ensure a sustained intern presence at the facilities.

DISCUSSION

In this study we explored HCW views on the acceptability and appropriateness of a novel strategy to increase human resources for health: placing youth interns as temporary LHWs in public sector health facilities to support HIV services. HCWs working with or supervising interns found this LHW approach to be a highly acceptable and appropriate strategy to strengthen HIV services in health facilities because they found the nature of the program to be appealing, specifically its altruistic goals; the implementation of the program to be easy, once interns were in place at the facility; and the results of the program to effective. Aspects of program implementation, namely the upfront burden posed by interns and limited communication, were barriers to acceptability and appropriateness. Overall, HCWs expressed strong affinity for YHA because they perceived its benefits to outweigh the costs, as they felt this program addressed healthcare worker shortages and benefited HCWs, patients, and interns alike.

Although the YHA strategy is novel, our results align with past research that has found HCWs generally have favorable views of LHW programs that support HIV services (21). Despite the youth and inexperience of YHA interns, our results corroborate past studies that show HCWs appreciate LHWs, even though training and supervising them can be burdensome, because LHWs reduce HCW workloads and improve clinic functions (11). Our findings show that how interns were introduced to facilities influenced acceptability and appropriateness is also reflected in the literature (21). Previous research in South Africa found HCWs were happier with LHW programs when they had agency in the implementation

process (22), which was also a key finding from our study. Interestingly, HCWs in our study did not describe some key barriers to acceptability and appropriateness that HCWs in previous studies experienced, namely worries about competition from LHWs or LHW incompetence (11,20,22,32–34). Rather, HCWs in our study described having positive interactions with interns and believed interns benefited patients. Overall, this suggests HCWs may find the YHA program to be as acceptable and appropriate as other LHW programs, if not more so precisely because of the goal that makes the YHA program different from other LHW programs: its focus on youth training and empowerment.

Our study is important as it highlights how altruism can impact HCW perceptions on acceptability and appropriateness of a program. We found that YHA's goal of youth empowerment appealed to HCWs' innate sense of altruism, which contributed to their favorable perception of this program. This impact of altruism should not be overlooked, as two global systematic reviews suggest altruism is a key driver of HCW happiness and motivation, which in turn reduces HCW attrition (9,10). These reviews specifically suggest policy makers develop HCW mentorship programs to promote HCW wellbeing, and thus retention, as mentoring increases HCW happiness by appealing to their altruistic nature (10). The results of our study resonate with this research, as we found HCWs expressly appreciated providing mentorship to youth LHWs. This suggests YHA could be a model worth replicating, as it could lead to improved HCW wellbeing and thus improved retention through two mechanisms: general reductions in workload leading to an improved workplace environment (8), but also by providing HCWs a greater sense of purpose by contributing to youth empowerment (9,10). The YHA approach could therefore be attractive to policy makers who are striving to find new ways to strengthen human resources for health.

Limitations

Although this mixed methods study provides a robust assessment of HCW perceptions of YHA, it was subject to several limitations. Firstly, we could only access HCWs working at facilities associated with Arum Institute and did not include facilities supported by other implementers of the YHA program, which limited the generalizability of our results. Secondly, our main survey questions had been validated in LMICs but not in South Africa. Thirdly, our interviewers were from Aurum Institute, which supported implementation of the YHA program; junior-level staff conducted interviews to reduce power differentials

and promote openness during interviews. Fourthly, our study was limited to the experience of HCWs and does not speak to the experience of the interns or the patients served at the facilities. Finally, while our research highlights how HCWs perceive YHA to impact the health facility, we did not objectively measure such impact in our study (e.g., patient wait time, youth outreach). Nonetheless, this study is important as it provides a robust assessment of how the novel YHA approach has been perceived by healthcare workers when implemented under routine conditions.

CONCLUSION

HCWs perceived having youth interns as temporary LHWs in facilities to be an acceptable and appropriate strategy to support HIV services in South Africa. While aspects of YHA implementation could be improved, HCWs found the program overwhelmingly acceptable and appropriate because YHA goals resonated with them, it was easy to engage the interns, and they found the program to benefit themselves, patients, and interns. In particular, HCWs resonated with the program's altruistic nature, finding satisfaction in mentoring youth interns, suggesting YHA may be an especially effective LHW approach to strengthen human resources for health. Before recommending scale-up, more research is needed to quantify the program's impact, understand its cost, and consider ways to reduce burden on HCWs and ensure sustained support.

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TABLES

Table 4.1. Characteristics of survey respondents (n=60). Surveys were conducted amongst healthcare workers who served as intern supervisors for Youth Health Africa.

	n	%
Location		
Northwest	33	55%
Ekurhuleni	27	45%
Current Position		
Data Monitor	18	30%
Counselling Supervisor	17	28%
Retention Supervisor	17	28%
Professional Nurse	1	2%
Data Capturer	1	2%
Other	6	10%
Years in Current Position		
Less than 1 year	9	15%
1-2 years	22	37%
3-5 years	26	43%
6-10 years	2	3%
11-15 years	1	2%
Duration as intern supervisor		
< 6 months	17	28%
6 months to 1 year	16	27%
≥1 year	27	45%
No. facilities where they supervise interns		
1	17	28%
2	15	25%
3 to 4	13	22%
5 to 9	8	13%
10 or more	4	7%
None currently	3	5%
No. Interns they currently supervise		
1	12	20%
2 to 3	16	27%
4 to 5	10	17%
6 to 10	2	3%
More than 10	7	12%
None currently	3	5%
Roles of interns they supervise*		
Programmatic	39	65%
Administrative	28	47%

*Facilities could have both programmatic and administrative interns

Table 4.2. Characteristics of interviewees (n=33) and their facilities (n=16). Interviews were conducted amongst healthcare workers who worked alongside Youth Health Arica interns.

	n	%
INTERVIEWEES	**33**	**100%**
Facility Type		
Clinic	17	52%
CHC/Hospital	16	48%
Interviewee Position		
Nurse/Clinician	18	55%
Admin Clerk	6	18%
Testing Counsellor	5	15%
Data Capturer	3	9%
Tracer	1	3%
Number Years at Facility		
≤1 year	4	12%
2-4 years	8	24%
5-9 years	12	36%
≥10 years	8	24%
Missing	*1*	*3%*
FACILITIES	**16**	**100%**
No. Interns at facility		
1	3	19%
2 to 3	9	56%
4 to 5	0	0%
6 to 10	1	6%
10 +	2	13%
Missing	*1*	*6%*
Roles of interns at facility		
Admin	12	75%
HTC	8	50%
Tracer	6	38%
Other	3	19%
Missing	*1*	*6%*

Table 4.3. Key themes from interviews with frontline healthcare workers (HCWs) (n=33) with quotes exemplifying the themes.

Theme	Summary	Illustrating Quotes
Theme 1: YHA is mutually beneficial to HCWs and interns	HCWs express strong affinity for YHA because [1] they find interns to be a useful set of extra hands to support a HCW's workload and [2] they believe YHA benefits youth and broader society.	*"*They are gaining experience; we are gaining extra hands. We are benefiting; they are benefiting." *(NW-6, Nurse, CHC/Hospital)* "[The interns] are so helpful, helping hands. Whatever they do." *(NW-5, Data capturer, CHC/Hospital)* "I feel so happy because…you grow a young kid who knew nothing, and you start seeing how much impact you play for her to be here." (*NW-11, Counsellor, Clinic)*
Theme 2: Facilities need agency when implementing YHA	HCWs appreciated having a say in how YHA was implemented at their facility and became frustrated if they lacked this agency. Lack of agency was connected to lack of communication with YHA.	"The intern program was not properly introduced to us….The first time I saw and heard of this program--the first time--I came in the morning, I found…they were navigators there….. So now, it was causing a confusion in the sense that you don't know who are these people, they were not introduced…." *(Gauteng-10, Nurse, CHC/Hospital)* "It seems as if now I am manager only [in a] vacuum because…when they take [the YHA intern] for the meeting they [do] not inform me….She doesn't report to me, even now she is not here, I don't know where is she." *(NW-10, Nurse, Clinic)*
Theme 3: Short internships can be burdensome	The short nature of an internship can be burdensome, as HCWs spend time training interns and grow dependent on their support for them to leave after one year with no guarantee of replacement.	"Honestly, the disadvantage [of YHA]? They employ people who don't have any experience. I have to come and show them the ropes, how are we doing the work here….For the first two weeks it was difficult, but my colleague, I think she is adapting very fast. So for now I don't have a problem, everything works smoothly." (*NW-16, Admin Clerk, Clinic)* "If they are leaving or [the] internships ends, there will be a gap, where I would be alone again, lots of work, with backlog." (*NW-5*, *Data capturer, CHC/Hospital)*
Theme 4: Success from YHA is more than numbers	HCWs believed YHA led to success in numerous ways in addition to progress towards HIV targets, such as smoother facility operations, improved HCW morale, and improved patient care.	"[YHA] benefits patients in a lot of ways, like for instance, our waiting time is reduced, our nursing care has improved, and our patient survey says a lot." *(Gauteng-13, Nurse, CHC/Hospital)* "You see, really if you have too much workload, you end up being exhausted and exhaustion brings burnout and end up with much absenteeism, so if we have more people working together, everything goes smoothly." *(NW-17, Nurse, Clinic)* "But now, it is easy when they are here. The work is…going smooth. The files, the doctors when they come, they find that the files are already on the chairs. They are ready because they are here since the morning. They prepare the files the day before….They put them on the boxes…..And when the patients come, they don't go far away, the files are here, nearer, they just take the file, then they take the file to the nurses, they do the vital signs, then the patients go to the doctor. It is very easy. Working is easy, smoothly." *(Gauteng-16, Nurse, CHC/Hospital)*

Table 4.4. Application of the Theoretical Framework of Acceptability (TFA) to summarize factors that promoted or hindered acceptability and appropriateness of Youth Health Africa as implemented under routine conditions in Gauteng and North West, South Africa.

TFA Domain	Facilitator/ Barrier	Integrated Findings	Key Data	
			Interviews	Surveys**
Nature of YHA				
Affective Attitude	Facilitator	HCWs liked participating in the YHA intervention, specifically because interns addressed healthcare worker shortages	Theme 1: YHA is mutually beneficial (*Interns alleviate HCW burdens*)	Almost everyone likes supervising interns (98%) and having their facilities host interns (97%)
Ethicality	Facilitator	HCWs liked that participation in the program gave them the chance to support young people and improve future society	Theme 1: YHA is mutually beneficial (*HCWs appreciate helping interns*)	Almost all feel good about the program as an on-the-job experience for youth (98%) and feel good about supporting the interns (97%)
Implementation of YHA				
Intervention Coherence	Barrier	HCWs lacked understanding of the program and what was expected of them, needing more communication with YHA staff, especially during initial stages of implementation	Theme 2: Facilities need agency (*Poor communication*)	Most feel the tasks they are asked to do as an intern supervisor make sense (87%) and fewer (67%) were satisfied with the orientation they received to be supervisor.
Self-Efficacy	Facilitator	HCWs were equipped to manage and supervise interns because it is similar to overseeing other staff.	Theme 2: Facilities need agency (*Easy integration)*	Most think supervising interns fits with their current job description (93%) and almost all had supervisory experience prior to participation in program (98%).
Facility Fit*	Facilitator	Youth interns were integrated easily into facilities because HCWs assumed responsibility for interns once they were placed at facility	Theme 2: Facilities need agency (*Easy integration*)	Almost all feel the intern program fits with the facility culture (98%) and how the health facility operates (98%)
Burden	Barrier	Supporting YHA could be burdensome for HCWs, as they needed to be trained by frontline HCWs and they increased supervisory responsibilities for intern supervisors	Theme 3: Short internships can be burdensome	Many think that tracking intern progress through paperwork is something they should be doing as part of their job (83%) and fewer are satisfied with the support received while supervising the interns (69%).
Opportunity Cost	Mixed	Opportunity costs appear low for all HCWs. While frontline HCWs think current benefits of program exceed costs, they express reservations that costs could exceed benefits if there are no plans to sustain help from interns.	Theme 3: Short internships can be burdensome	Most feel the health facility can support interns without negatively affecting other services (90%), and given other needs, it is worth allocating the resources to host interns at the health facility (91%). 85% think the benefits of YHA are equal to or outweigh the time required of them.

Continued on next page

Table 4.4 continued

TFA Domain	Facilitator/ Barrier	Integrated Findings	Interviews	Surveys**
Results of YHA				
Perceived Effectiveness	Facilitator	HCWs perceive YHA to be effective, contributing to a wide range of positive outcomes for healthcare workers, the facility, and its patients	Theme 1: YHA is mutually beneficial Theme 4: Success is more than numbers	Almost everyone feels the health facility benefits from having youth interns (98%), that YHA is effective in addressing staff shortages (96%), and that youth interns in the clinic have helped the facility be more successful (96%).

*TFA was developed by Sekhon et al. 2017 (31). 'Facility fit' was added by study authors.

** All responses are presented for scores of 'moderate' or 'a lot'

FIGURES

Figure 4.1. Overview of the Theoretical Framework of Acceptability (TFA) domains, as defined by Sekhon, et al (31), with addition of domain 'facility fit' influenced by the definition of 'appropriate' by Proctor, et al (19). Domains were grouped into three groups by this study's authors.

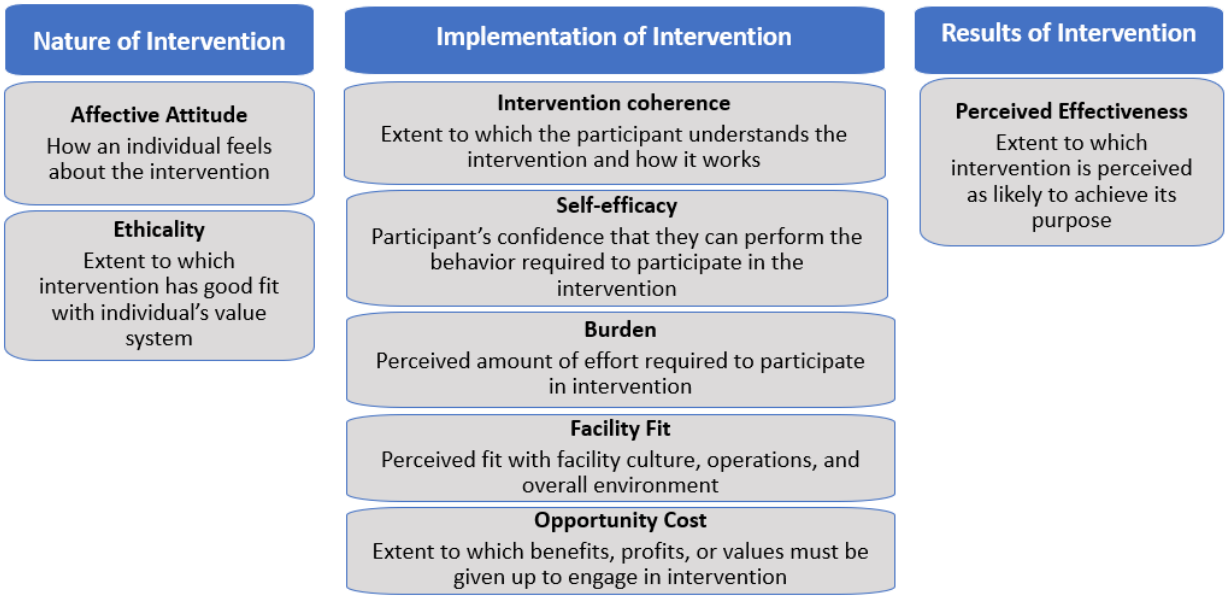


Figure 4.2. Distribution of overall average acceptability and appropriateness scores for intern supervisors, by province (n=60). Average scores of acceptability and appropriateness correspond to the following scale: 1=Not at all, 2=A little bit, 3=A moderate amount, or 4=A lot.

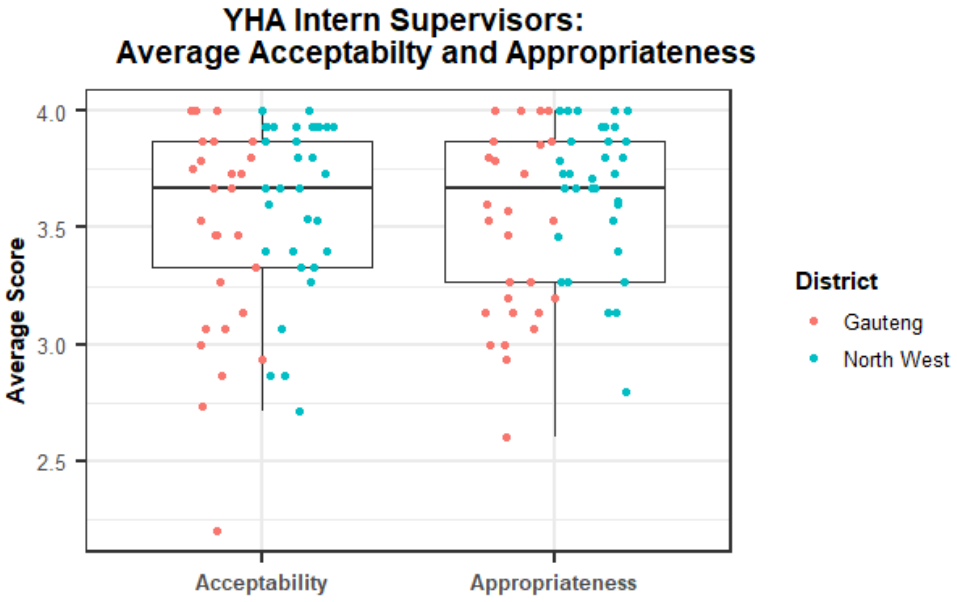


Figure 4.3. Summary of responses to acceptability and appropriateness questions on survey (n=60 intern supervisor respondents).

***Figure 4.3A*: Responses to questions from perceived acceptability measure**

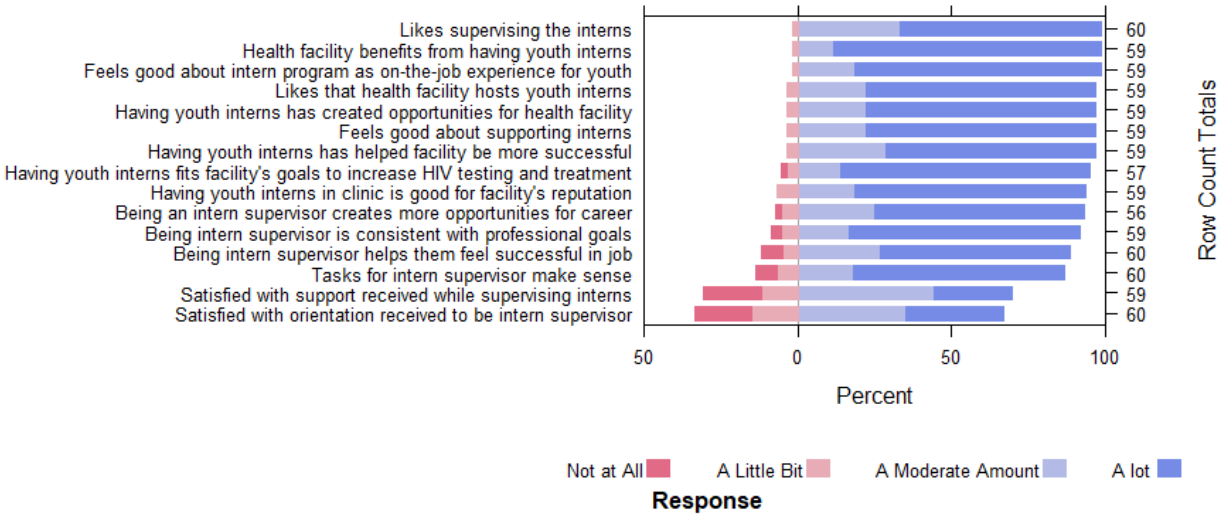
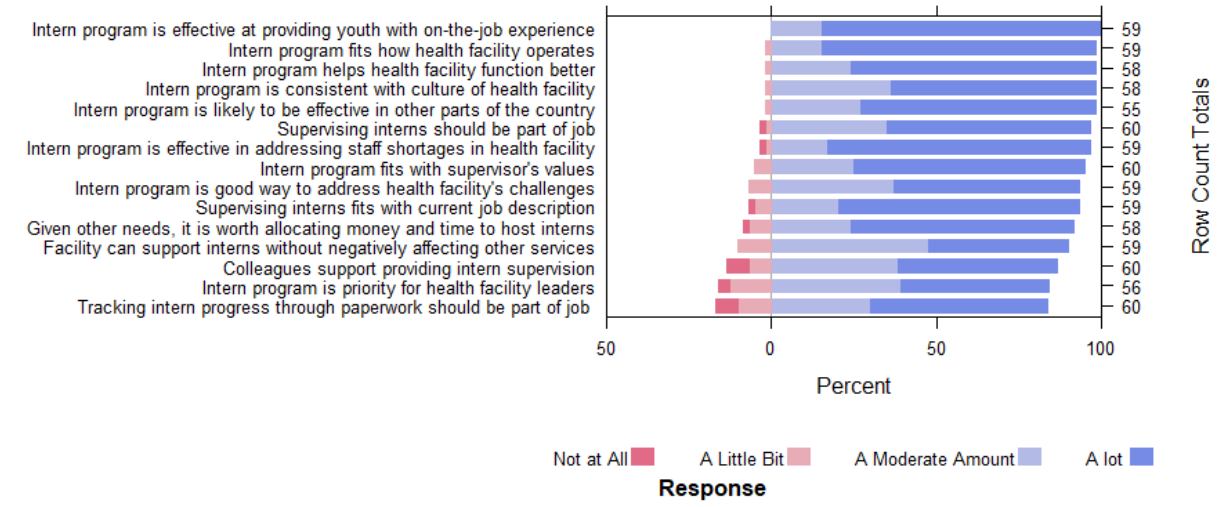


***Figure 4.3B:* Responses to questions from perceived appropriateness measure**



APPENDIX A: Bivariate logistic regression results

Table 4A.1: Bivariate logistic regression analyses examining associations between intern supervisor characteristics and low total acceptability & appropriateness scores.* *Row percentages are presented to support interpretation***.**

Variable	Lowest Acc & App* (n=13)	Higher Acc or App (n=22)	Unadjusted OR	95% CI (Low)	95% CI (High)	p-value
1. Province						
Gauteng	9 (33%)	18 (67%)	REF			
North West	4 (12%)	29 (88%)	0.3	0.07	1.1	0.06
2. Gender						
Male	5 (20%)	20 (80%)	REF			
Female	8 (23%)	27 (77%)	1.2	0.3	4.4	0.8
3. Supervisor Position						
Data monitor	2 (11%)	16 (89%)	REF			
Counseling supervisor	3 (18%)	14 (82%)	1.7	0.2	13.2	0.6
Retention supervisor	5 (29%)	12 (71%)	3.3	0.5	22.4	0.2
Other (includes nurses)	3 (37.5%)	5 (62.5%)	4.8	0.6	42.1	0.2
4. Duration in Current Position						
<1 year	3 (33.3%)	6 (66.7%)	REF			
1-2 years	3 (14%)	19 (86%)	0.3	0.05	2.2	0.2
3 or more years	7 (24%)	22 (76%)	0.6	0.1	3.5	0.6
5. Duration as Intern Supervisor						
<6 months	3 (18%)	14 (82%)	REF			
6-12 months	5 (31%)	11 (69%)	2.1	0.4	11.8	0.4
1 or more years	5 (18.5%)	22 (81.5%)	1.1	0.2	5.6	0.9
6. Current no. Interns**						
1-2 interns	7 (25%)	21 (75%)	REF			
3-4 interns	1 (7%)	13 (94%)	0.23	0.02	2.4	0.2
5+ interns	4 (27%)	11 (73%)	1.1	0.2	4.9	0.9
7. Current no. Facilities with Interns**						
1 facility	5 (29.4%)	12 (70.6%)	REF			
2 facilities	2 (8.3%)	22 (91.7%)	0.2	0.03	1.4	0.1
3 or more facilities	4 (25.0%)	12 (75.0%)	0.8	0.2	4.0	0.8
8. Intern Role						
Program, no admin	9 (30%)	21 (70%)	REF			
Admin, no program	2 (10%	17 (90%)	0.27	0.04	1.6	0.2
Admin & program interns	1 (11%)	8 (89%)	0.29	0.03	3.1	0.3
Other	1 (50%)	1 (50%)	2.33	0.11	49.1	0.6

*Total score for acceptability and total score for appropriateness were <=50, i.e., scores in the lowest quartile. **3 responses missing.

NOTE: Lower scores were uncommon, which is why we designed analysis to look at lower scores. It was not possible to differentiate extraordinarily high scorers, as most respondents had very high scores. We wanted to define "low" scores by having <= average score of 3 (moderate), but there were too few cases to examine. We did not run a multivariate regression analysis, as there were no significant findings in the unadjusted analysis.

CHAPTER 5. Costing analysis of a lay health worker program using temporary, youth interns in South Africa

Deanna Tollefson[1], Nasiphi Ntombela[2], Sarah Reeves[3], Farai Mzungu[3], Geoffrey Setswe[2,4], Salome Charalambous[2,5], Ann Duerr [1,6], Carol Levin[1]

1: University of Washington, Department of Global Health, Seattle, United States

2: The Aurum Institute, Implementation Research Division, Parktown, South Africa

3: Youth Health Africa, Parktown, South Africa

4: Department of Health Studies, University of South Africa, Pretoria, South Africa

5: School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

6: Fred Hutchinson Cancer Research, Vaccine and Infectious Disease & Public Health Science Divisions, Seattle, United States

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INTRODUCTION

A robust healthcare workforce is needed to create healthy societies and achieve global health and development goals (1). Nonetheless, there has been chronic underinvestment in the health workforce, resulting in a projected shortfall of 18 million healthcare workers by 2030, concentrated in South Asia and sub-Saharan Africa (1,2). Lay health workers (LHWs), defined as persons without professional or paraprofessional qualifications who support health work, are critical to fill this gap (3,4), but it remains challenging to fund LHW programs (5). LHW programs, which are inclusive of community health workers, are generally believed to be cost-effective and cost saving (2,6,7), but development assistance is proportionally small and has decreased over time (8). There are also few domestic government resources allocated to these programs compared to other health expenditures (2). As such, there is a growing gap between funds available and the funding required to support LHWs (9), creating a need to identify new avenues to fund LHW programs and bolster commitment to human resources for health (1,2,6).

Youth Health Africa (YHA) offers a novel approach to LHWs in South Africa. YHA places young adults as temporary LHW interns in health facilities to support HIV service delivery. The program is unique because it is designed as a workforce training program with a focus on youth empowerment (10). This has enabled it to leverage an uncommon funding stream in global health: the private sector. Businesses fund internships through YHA because of its focus on building the South African workforce. Ultimately, YHA strives to reduce youth unemployment, a challenge faced across Sub-Saharan Africa (11–15), which could engage funders outside the health sector who fund youth employment programs, such as the African Development Bank[1] (15,16).

The YHA program appears effective in improving HIV service delivery and is well accepted by healthcare workers (17–19),[2] but the cost to implement the program is not known. Understanding the full cost to

[1] The African Development Bank has a specific focus on reducing youth unemployment, as highlighted in its "Jobs for Youth in Africa" strategy. It has focused on providing youth training opportunities in the agricultural, manufacturing, and information and communication technologies sectors, but not the health sector. See https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/jobs-for-youth-in-africa for more details.
[2] Our research has not assessed all benefits to this program. Numerous other benefits to YHA, such as reductions in youth unemployment and the subsequent societal outcomes, are likely but have not been assessed by our research.

implement global health interventions is necessary to improve their uptake and efficiency (20), which in turn can be used to garner the support necessary to expand programs. In the case of YHA, this information is needed to attract new funders, such as the African Development Bank. We conducted a costing study from the provider perspective to estimate the cost of the YHA approach to support an understanding of the program's affordability with the goal to [1] facilitate decision making about whether this program is implemented and [2] support improved efficiency of the program as it is scaled or adopted in new settings. This study was conducted by the University of Washington (Seattle, USA) and the Aurum Institute (Johannesburg, South Africa).

THE INTERVENTION

YHA is a non-governmental organization (NGO) focused on reducing youth unemployment while addressing social determinants of health (10). Their primary program, which we will refer to as the "YHA program," is a skills development program for youth implemented in health facilities. It involves hiring young adults (18-30 years old) without work experience as LHW interns to support HIV work in publicly run health facilities in their communities for one year. In this costing study, we define the intervention to be the YHA program. This intervention has been explained in detail elsewhere (10,18,19). Specifics relevant to this costing study are described below.

Activities

The YHA program involves a series of ongoing activities that can be categorized into intern planning, intern placement, intern work, intern support, and program support (Table 5.1).

Intern Planning: On a regular basis, YHA staff work to identify funding for interns through meetings with prospective donors and completing funding applications. They also reach out to NGOs and district health staff to select the health facilities where interns will be placed.

Intern Placement: When funding becomes available for a cohort of interns, YHA recruits and hires interns who are then onboarded to positions at health facilities. Onboarding involves paperwork for human resources, a 3–5-day work-readiness training provided by YHA, an orientation provided by a health facility manager, and on-the-job training provided by the healthcare worker whom the intern will work alongside.

Intern Work: The primary program activity is interns working at health facilities to support HIV-related services ranging from testing and counseling to filing patient records. While interns are given 12-month assignments, the length of time they work can vary based on personal interests and funding streams.

Intern Support: There are a large number of support activities provided to interns and facilities during the internship. Firstly, interns are supervised by healthcare workers (HCWs) and by YHA program staff. Supervision by HCWs is in-person and includes monthly feedback to the YHA program. Intern supervision is also provided, mostly remotely, from YHA staff. Secondly, YHA staff provide support to facilities where interns work through routine check-ins with HCWs. Thirdly, YHA arranges monthly professional development workshops ("development days") for interns to improve general workplace skills (e.g., computer literacy, leadership). These are generally led by YHA staff but are sometimes outsourced to another NGO. Finally, as the end of the internship period approaches, YHA staff support interns to prepare for employment by providing guidance on CV development and the job search.

Other activities: YHA provides broad, programmatic support through marketing, idea generation, and routine administrative tasks. Another NGO provides broad monitoring and evaluation support.

Actors

The providers of the YHA intervention include the program providers (YHA program and collaborating NGOs) and HCWs at publicly run health facilities. There are three categories of healthcare workers that help provide this program: facility managers (a nurse or operational manager who oversees the unit where the intern works), facility colleagues (a nurse, nursing assistant, data capturer, tracer, HIV tester and counselor, or other admin staff whom the intern works alongside at the facility), and intern supervisors (a HCW in a supervisory position who works across multiple facilities).

Implementation to Date

The YHA program started in mid-2018. YHA became an independent NGO in March 2020 and focused almost solely on the intervention described above through September 2021. More than three-thousand interns have been placed in facilities across South Africa since YHA began.

METHODS

Study Design

The costing study took place as part of a larger cross-sectional assessment of the YHA program (19). The YHA program is incremental to the established public health system. We estimated the total cost of the YHA program incremental to the public health system from the provider perspective, as it was implemented from March 2020–September 2021. The provider perspective included costs incurred by the NGOs and healthcare workers who implemented this program; it did not include broader costs to the health system, such as costs incurred as a result of extra services provided because of interns (e.g., additional HIV tests conducted, additional patients seen). This costing study involved reviewing program expenditures and estimating intervention costs incurred by facilities; the latter costs were estimated through surveys and interviews with a sample of 61 healthcare workers in North West and Gauteng provinces in May 2021.

We estimated both financial and economic costs through top-down and bottom-up methods using activity-based costing. We defined financial costs as the resources that were paid for in running this intervention and economic costs as the opportunity cost of using resources for this intervention (namely time spent by healthcare workers to support the intervention). We determined the scope of the costing study after meeting with YHA program staff, where we outlined implementation activities and actors (described above). For each activity, we identified resources needed to deliver the program, such as personnel time and transportation, lodging, and per diem for travel.

Time Period

We estimate the total incremental cost of the YHA program for the period March 2020 to September 2021 (which we refer to as the ‘study period’), when the program was in steady state (i.e., after the program was fully established). This period was chosen because this was the longest period for which financial records were available and YHA resources were fully devoted to this intervention. Because the YHA program was in steady state during this time, no start-up costs were included in this analysis.

Data Collection and Estimating Costs

We used primary and secondary data to estimate the full cost of the YHA program incremental to the existing public health system (Table 5.2). All data were collected retrospectively. For primary data collection, we used a time-driven activity-based costing as described by Cidav, et al (21) to document the activities of people supporting the intervention and the time and resources they spent on these activities. Inputs for each cost category are summarized in Table 5.3.

We used secondary data sources, including the YHA accounting ledger and program documents (e.g., invoices, receipts, budgets, and contracts), to obtain program financial expenditures for the study period. Interviews with YHA staff guided our review of the ledger by highlighting the main activities and costs associated with activities. We cross-checked the ledger with program staff and supplemented it with existing program data where necessary. We reviewed all categories in the ledger, the corresponding entry descriptions, and the number of entries to determine whether costs should be included in this analysis. Costs that were unclear and <$1,000 USD were excluded. Duplicate entries were common; we used our best judgement to identify unique costs by examining dates, invoice numbers, and descriptions. Even though the program was supported with donor funding, this was not considered in our analysis. We aggregated line-item costs included in this analysis in R 3.6.1 (R Core Team 2019, Vienna, Austria).

Through interviews with YHA leadership, we identified shared program costs that were not covered in the ledger or program documents, most notably, the time contributed by healthcare workers. To capture these additional resources, we interviewed 33 frontline HCWs from 16 clinics and community health centers/hospitals who worked alongside interns, and we surveyed 28 HCWs who were intern supervisors. All sampled HCWs worked in Gauteng and North West provinces. Data collection relied on self-reports of average time HCWs spent on intervention activities, which we collected through a two-step process. In interviews, we first inquired about how HCWs engaged with the YHA program, then asked about the typical amount of time each engagement took. In surveys, we first inquired about how often in a week or month the HCW engaged in a specific activity (e.g., providing one-on-one support to an intern or completing supervisory paperwork), then asked about the typical amount of time it took to do that activity one time. We calculated a HCW's total time on the program by multiplying frequency of activity and time

required to do the activity once. We did not specify recall to a predefined time period due to natural fluctuations in engagement that occur over the internship period. Rather, we asked HCWs to recall the typical time spent on specific program activities in an average week or month and inquired about how this time changed throughout the internship period.

Finally, in October 2021, we interviewed YHA program staff (14 of 15 employees) to allocate their worktime to specific YHA activities, using a two month recall period. We assumed the overall time spent per activity remained similar month to month and applied this proportion to program staff time for the whole study period. We also used these interviews to capture the frequency and purpose of travel, which we used to estimate the extent of travel for the full study period.

Valuation and Pricing

We estimated the economic costs of HCW time by collecting self-reported information on time they spent supporting this intervention (see above). We valued HCW time by multiplying the total average time they spent per internship by the average salary for the type and level of HCW engaged with this program. Salaries were obtained through South African public employee pay scales. HCW salaries were adjusted for inflation to be in 2021 South African Rand using the South Africa GDP deflator from the Organization for Economic Co-operation and Development (OECD)[1]. Capital costs (i.e., costs for computers and car) were depreciated at a 3% discount rate, assuming 10 years of useful life.

We used local prices (South African Rand) for all measures. YHA program costs incurred in 2020 were adjusted for inflation to be in 2021 currency using the South Africa GDP deflators reported by OECD. All prices were converted to dollars using the exchange rate from January 1, 2021 ($1USD = 14.65 ZAR) as reported by ONANDA. No adjustments were made to reflect quality of service.

Intervention outputs and assumptions

Based on YHA program data, 2,127 interns were placed in internships in 618 different facilities across South Africa during the study period (Table 5.4). An average of 3-4 interns were placed per facility.

[1] Organization for Economic Co-operation and Development, GDP Implicit Price Deflator in South Africa [ZAFGDPDEFQISMEI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/ZAFGDPDEFQISMEI, May 4, 2022

Interns and facilities had staggered start and end points during this period. Some interns began internships towards the end of the study period and thus did not have time to complete a twelve-month internship. Start/end dates were available for approximately 70% of interns, which we used to calculate the average number of months an intern worked during this study period (7 months); we assumed this to be the average length of intern placement for all interns during this study period. Data on the start/end dates for facility engagement were not available. In our primary analysis, we assumed that the interns at one facility started and ended their internships at the same time; we thus assumed the average length of facility engagement matched the average length of intern engagement (7 months).

In consultation with YHA leadership, we also made assumptions about the number of HCWs involved in this intervention. We assumed there was one facility colleague per intern (2172 facility colleagues); one facility manager per facility (618 facility managers); and one intern supervisor per 10 interns (213 supervisors) and that they supervised interns across three facilities.

Finally, we made assumptions about travel in consultation with YHA leadership and review of financial expenditures. We assumed the average cost per overnight trip was 4,500 ZAR (307.17 USD). We calculated the reimbursement for day travel based on a government standard of 3.7 ZAR (0.25 USD) per kilometer and assumed the average facility visited was 50 km (37.07 miles) from the YHA staff or intern supervisor's office.

Cost metrics

The cost metrics for this analysis were the incremental total cost of the YHA program, the cost per intern per year, and the cost per health facility per year presented in 2021 USD. Cost per intern is defined as the total incremental cost divided by total number of interns placed for an average of 7 months. Cost per facility is defined as the total incremental cost divided by the number of participating facilities.

Data Analysis

All data were entered and analyzed in Microsoft Excel 365 Version 2203 (Microsoft Corporation, Redmond, WA). We first calculated the total estimated incremental cost of the YHA program to the health sector for the study period (Table 5.5). Most financial costs were available for the whole study period, but

only monthly estimates were available for intern pay, HCW time, and YHA and HCW travel. We estimated the total cost for these inputs for the study period as follows:

- *Intern pay* was calculated as average monthly pay * average length of intern placement * total number of interns
- *HCW time* was calculated as average time per month * average monthly salary * average length of intern placement * total number of interns.
- *YHA staff travel* was calculated as average number of monthly trips * average cost of trip * 19-month study period
- *HCW travel* (only taken by intern supervisors) was calculated as average number of monthly trips to facilities per intern supervisor * average length of internship period * total number of intern supervisors * average cost per trip

After aggregating all costs for the study period, we calculated the estimated cost of the program per intern per year and per facility per year, assuming the average intern was placed for seven months, and the average facility was engaged with the program for seven months. These calculations also assume that each month of intern placement was comparatively priced and that there were 3-4 interns placed together per facility. Cost per facility per year assumed that there were 618 health facilities engaged with the program for an average of 7 months each during the study period. See Figure 5.1 for calculations.

We disaggregated total incremental costs by cost category, actor, and program activity to elucidate cost drivers for this intervention and understand costs incurred by health facilities.

Scenario Analysis

After calculating our cost metrics, we estimated the cost to scale the program to all publicly funded primary health clinics and centers in South Africa. We identified the total number of public primary health clinics and centers in South Africa (3,841 facilities) (22). Assuming an average of 3-4 interns were placed per facility, we estimated the cost to implement the program when in steady state in all facilities (cost per facility per year *3841 facilities). We also estimated the cost for the first year of implementation by adding 2.5% to total costs to account for start-up expenses (cost per facility per year *3,841 facilities *1.02). We selected this estimate based on the assumption that the activities that would be amplified during the start-

up period (e.g., identifying funding and health partners) would approximately double; start-up-specific costs are believed to be low for the YHA program. To begin discussion of affordability, we compared this to the total National Department of Health budget for 2021-2022 (62.5 billion ZAR or 4.27 billion USD) (23), although YHA could be funded by a variety of entities outside the health sector.

We did not cost scale up for one intern per facility as the cost per intern is dependent on having an average of 3-4 interns per facility. The cost for a single intern at a facility would be higher than the cost per intern if multiple interns were placed, due to some costs (e.g., supervision) being dependent on number of facilities, not number of interns. In addition, past research suggests the impact of the YHA program may be dependent on having at least three interns per facility (18), so we assume implementers would wish to place an average of 3-4 interns per facility if scaling this intervention.

Sensitivity Analysis

We conducted three sensitivity analyses, varying the categories where we had the most uncertainty (Appendix A). The first two sensitivity analyses varied HCW time spent onboarding and supervising interns (±50%), the estimated cost of overnight trips (±1500 ZAR), and the estimated distance YHA staff and HCW intern supervisors traveled to reach facilities for day trips (±25 km for one-way distance). We varied HCW time based on variability observed among the HCWs we interviewed; we varied travel costs based on lower and upper thresholds for estimates. The first sensitivity analysis was done based on the low estimates for the above-mentioned parameters; the second used the upper estimates. In the third sensitivity analysis, we varied our assumption about the length of time facilities were engaged with YHA during our study period. We assumed interns were staggered at facilities (different start/stop times), which increased the length of facility engagement to be 12 months. This would increase the amount of time that HCWs spent onboarding and supervising interns, but it would also increase the denominator used in calculating the cost metric for facility engagement from 7 to 12 (see ‘E’ in Figure 5.1).

Ethics

This study was approved by ethics committees at the University of the Witwatersrand (Johannesburg, South Africa) and the University of Washington (Seattle, USA). It was also approved by the

district/provincial ethics committees where primary data were collected from healthcare workers. Informed consent was received from healthcare workers and project staff prior to engaging in surveys or interviews.

RESULTS

Total and Unit Costs

The estimated total cost for the YHA program between March 2020 and September 2021 was $8.81 million, during which 2,127 interns were placed in internships in 618 different facilities across South Africa (Table 5.6). We estimated that the program cost $7,014 per intern per year and $24,142 per facility per year.

Drivers of Cost

Personnel comprised the largest costs for this program (77.0%), followed by overhead expenditures (17.1%). Intern labor constituted half of the overall costs of the intervention (49.9%) (Table 5.6). Personnel costs were driven primarily by the cost of interns working at the facility, followed by the time required from HCWs to onboard and supervise interns (Appendix B). The cost of HCWs was driven by their role in the clinic, amount of initial training required for the intern, and frequency of supervisory visits. Overhead costs, the second biggest driver of costs, were driven by general program monitoring and evaluation done by a partner NGO. Travel costs, the third costliest aspect of this program, was driven by onboarding and supervision costs.

Cost by Program Activity

Figure 5.2 explores costs by program activity. The costliest program activity was interns working in health facilities. Cross-cutting program support constituted the largest expense for general implementation of this program, followed by supervising interns and onboarding interns. Costs of other activities were negligible in relation to the overall program.

Costs by Actor

Table 5.7 and Figure 5.3 show the costs by provider. The YHA program and its partners incur most of the costs for this program, but health facilities shared program costs accounting for 21% of overall costs. Health facilities incurred most costs related to placing interns (onboarding) and supporting interns (intern supervision). Most time required for HCWs in the facility manager and colleague role was in the first

month of intern placements, as they provided interns on-the-job training and orientation to the facility. The time required of them for routine supervision was minimal. HCWs serving as intern supervisors spent an average of 6 hours a week supervising interns throughout the program. The time HCWs spent on this program is summarized in Appendix C.

Sensitivity Analysis

The first two sensitivity analyses suggest the total costs of the YHA program could vary from $5,278 to $8,791 per intern per year and $18,167 to $30,257 per health facility per year (Table 5.8). In the third sensitivity analysis where we assumed interns had staggered start dates, thus lengthening the time of facility engagement, the estimated cost per facility per year was $16,105.

Scenario Analysis

We estimate it would cost $96.3 million to scale the YHA program to all public health clinics and centers in South Africa in the first year, assuming an average of 3-4 interns per facility. On a recurrent basis, we estimate it would cost approximately $93.9 million to run this program at all facilities. This would comprise 2.3% of the 2021-2022 National Department of Health budget (Table 5.9). The sensitivity analysis suggests the cost to scale this program to all public health clinics/centers could range from $63.4 million to $119.1 million (Appendix C).

DISCUSSION

Our study estimated the cost of a novel facility based lay health worker program as implemented in South Africa (the YHA program) from the provider perspective to be $7,014 per intern per year (sensitivity analysis range: $5,278 to $8,791) or $24,142 per facility per year ($16,105 to $30,257). Half of total estimated costs were for intern labor, with healthcare worker time and overhead comprising the second and third highest costs (19.9% and 17.1%, respectively). Personnel was the largest cost driver and was influenced heavily by the cost of intern labor, followed by time required to onboard and supervise interns. Although HCWs are a substantial driver of YHA program costs, the total hours spent by HCWs on this program are a small fraction of overall work time.

Our study fills a gap in the literature, as there is a paucity of data on the full cost of LHW programs (2). Past studies have often failed to consider cost of supervision and retention in their cost estimates (6).

Cost estimates that are more comprehensive have varied widely based on location and program type, which can make comparing costs of LHW programs challenging (2,6). However, a recent study assessed the cost of community health worker programs at steady state from a comparable perspective as the one used in our study (2). After we adjusted this study's findings to be in 2021 USD, we see this study found the average annual program cost per community health worker in South Africa to be $8,304, which is slightly higher than the cost per intern per year we calculated for the YHA program ($7,103) (2). While a community health program is just one type of LHW program and has noticeable differences from the YHA approach (e.g., regular travel in communities), the similarity in cost suggests the YHA program is comparable in cost to other LHW programs. This is noteworthy, as it suggests the YHA program's focus on youth empowerment and workforce training does not make it more expensive than standard LHW programs. While additional research is needed to assess the program's impact on youth, the potential of YHA to empower youth while providing a critical health service at a similar cost to existing LHW programs may make this approach attractive to policy makers looking to bolster the health system or those looking to engage young people in the formal employment sector (13–15).

Affordability

Affordability of healthcare programs can be difficult to assess and is ultimately determined by the payer (24,25). For a program like YHA, this could be policy makers in the health sector. South Africa's community health worker program has been considered affordable due to its estimated low cost compared to the overall national healthcare budget (e.g., <2.5%) (26). Our study suggests the YHA program could be similarly affordable to South Africa's National Department of Health (NDoH), as it would constitute a small portion of its budget if scaled across the country; it would be even more affordable if it were implemented strategically in a portion of health facilities facing the greatest need.

However, we believe the YHA program may be even more affordable to the government than traditional LHW programs, as its multisectoral nature could attract payers outside the health sector. We have already observed that the YHA program is of interest to private businesses, as this has been its predominant funding mechanism in South Africa. The program's focus on youth employment and job training may make it of interest to other governmental departments in South Africa, such as the Youth

Employment Service located in the office of the Presidency or the Department of Employment and Labor; these departments may find that reductions in youth unemployment due to YHA offset some of the program's costs, making the program very affordable to implement, but additional research would be needed to assess this.

The YHA program may also be of interest to intergovernmental agencies focused on economic development. The African Development Bank has an expressed interest in funding youth employment programs to combat high youth unemployment and thus bolster economic growth in Africa (15,16). To date, it has youth employment programs in agriculture, information technology, and general industrialization, but not health (27,28). Other programs focused on reducing youth unemployment in Africa have similarly not included the health sector (13,14). Our study, in conjunction with past research on the effectiveness and acceptability of the YHA program (18,19), suggest the health sector could be considered in these development programs. This program's ability to appeal to non-traditional payers of public health programs could bring more resources to the table, which could increase its affordability and enable it to help bridge the gap in LHW funding (9).

Improving Efficiency

It is unsurprising and appropriate that labor spent for intern onboarding and supervising interns were large drivers of cost for the YHA program, as strong training and supervision are essential for successful LHW programs (2,29). However, the YHA program could be modified to reduce these costs without sacrificing training or supervision and thus improve efficiency.

Lengthen internship to two years: The YHA program is currently a one-year program but could be lengthened to two years. This would spread the cost of onboarding over a two-year period, thus reducing the cost per intern per year. This modification aligns with health sector interests, as HCWs generally want interns to be placed for longer than one year (19). A two-year period is also common in health-based work experience programs for youth in other countries (e.g., the Peace Corp[1] or the Public Health Associate Program[2]). Lengthening the internship period could be advantageous to the youth's future

[1] Peace Corp: https://www.peacecorps.gov/volunteer/is-peace-corps-right-for-me/50plus/
[2] Public Health Associate Program: https://www.cdc.gov/phap/index.html

employability, providing them an opportunity to further develop work skills. If intern retention is a challenge, this modification would have little impact on efficiency.

Engage facilities that can support multiple interns: Supervision costs were most dependent on number of facilities rather than number of interns. Placing interns in facilities that can accommodate a larger number of interns could thus reduce supervision costs. This could also promote improved efficiency as past research suggests this program may have a larger impact on facilities that host more interns (18).

Study Limitations

This study was subject to several limitations. Firstly, our analysis was limited by having a cross-sectional study design. We costed a complex, ongoing program, which was regularly hiring interns, so we could not isolate the cost for one cohort of interns over a twelve-month period; our metric 'cost per intern per year' is an approximation and could be influenced by variations in cost by stage of the program (e.g., if the program is more costly upfront because of onboarding, our costs could be overestimates). The complexity of this program and the cross-sectional data also prevented us from assessing the cost of a single intern placed at a facility; we could only estimate costs based on an average of 3-4 interns placed per facility.

Secondly, our study was limited by data availability. Our primary data collection relied on HCWs and YHA staff to self-report the time they spend on this project and its activities, as this intervention did not lend itself to observation; self-reporting could have been subject to recall bias, especially amongst HCWs where recall was not limited to the past month. In addition, our sample of HCWs was limited to those working in two provinces, while the YHA program has been implemented across South Africa. Our secondary data were also limited. HCW salary scales from the most recent year were unavailable, and exact positions/levels of all HCWs supporting YHA were unknown. The program accounting ledger was also incomplete and did not necessarily lend itself to analysis, so we relied heavily on bottom-up costing methods through meetings with YHA staff. We also lacked data on number of patients served directly or indirectly by interns in the YHA program, thus we were unable to estimate cost per patient served, a common cost metric used in other studies.

Finally, our study was limited in scope. We conducted this analysis for the YHA program in steady state and did not include start-up costs, which underestimates the total cost to implement the program.

However, our study also did not consider broader societal costs, which we hypothesize the YHA program may decrease, as youth unemployment has been linked to increased risky behavior and poorer health (30,31). This suggests the YHA program steady state costs estimated in this study may actually be conservative.

Additional research is needed to fully consider the program's affordability (e.g., a budget impact assessment) and how these could change under new models of implementation. Ultimately, a cost-effectiveness analysis would be useful to assess the value of investment in YHA in comparison to other interventions designed to support HIV service delivery, increase support to healthcare workers, or reduce youth unemployment.

CONCLUSION

Our study estimated the full incremental cost of a novel lay health worker internship program in South Africa from the provider perspective (program and healthcare workers). Its cost appears comparable to existing community health worker programs in South Africa, even though it is a workforce training program with a focus on economic empowerment for youth adults. The unique focus of this program and its comparable cost to the existing community health worker program in South Africa may make it of interest to policy makers as it could galvanize alternative funding sources to support expanded lay health worker capacity.

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TABLES

Table 5.1. Overview of activities that comprise the Youth Health Africa program and the actors supporting these activities

Broad Activity	Specific Activity	Program Staff		Health System		
		YHA	Other NGO	Facility colleague	Facility Manager	Intern Supervisor
Intern Planning	Identify funding	X				
	Identify health partners	X				
Intern Placement	Recruit interns	X				
	Onboard interns	X		X	X	
Intern Work	Interns work in facilities	X				
Intern Support	Supervise interns	X			X	X
	Support facilities to supervise interns	X				
	Provide interns professional development	X	X			
	Prepare interns for post-internship	X				
Program Support	Cross-cutting program support	X	X			

Table 5.2: Data sources for costing analysis of the Youth Health Africa program

COST CATEGORY	Surveys (n=28)	HCW Interviews (n=33)	YHA Interviews (n=14)	Program Ledger	Program Documents	YHA leadership
Personnel – Interns				X		X
Personnel – YHA Staff			X	X	X	
Personnel – Healthcare Workers	X	X				
Meetings			X	X		X
Travel	X		X	X		X
Equipment/Supplies				X	X	X
Overhead				X		

Abbreviations: YHA = Youth Health Africa; HCW = Healthcare Workers

Table 5.3. Cost categories and corresponding inputs for costing analysis of the Youth Health Africa program

Cost Category	Inputs
Personnel	Paid time – Intern salary and benefits Paid time – YHA program staff salary and benefits Opportunity cost (Paid time) – HCW: Intern supervisors Opportunity cost (Paid time) – HCW: Facility manager Opportunity cost (Paid time) – HCW: Facility colleague
Trainings & Meetings*	Specific training costs for work readiness training and development days Professional development training led by other NGO Staff training/meetings
Travel	Transportation, lodging, per diem – YHA Transportation – HCW Intern Supervisors
Equipment & Supplies	Car Laptops Equipment maintenance Software & Databases YHA staff uniforms
Overhead	Facility and utilities General admin costs Audit fees Consulting services Program monitoring & evaluation led by other NGO

Abbreviations: YHA = Youth Health Africa; HCW = Healthcare Worker

Table 5.4. Intervention outputs for the Youth Health Africa program during study period (March 2020 – September 2021)

	Total Involved	Assumed Average Duration
Interns placed	2172	7 months
Facilities engaged	618	7 months

Table 5.5. Calculation of total cost of the Youth Health Africa program for the study period (March 2020-September 2021)

Data Sources	Cost Inputs	Timing of Available Data	Calculation
Financial Costs			
Accounting Ledger YHA Leadership	Intern salaries & benefits	Monthly	Monthly salary x 7 months internship x 2172 interns
Accounting ledger	YHA salaries & benefits	Full Study Period	Sum of all inputs
Accounting ledger Program documents YHA leadership	Trainings & meetings	Full Study Period	Sum of all inputs
Accounting Ledger YHA leadership YHA staff interviews	Travel - YHA	Monthly	Monthly travel frequency x Average cost per trip X 19 month study period
Accounting Ledger	Travel - Interns	Full Study Period	Sum of all inputs
Accounting Ledger Program documents	Overhead	Full Study Period	Sum of all inputs
Economic Costs			
HCW interviews	Facility colleague time	Monthly	Estimated time x Average salary x7 months internship x 2127 facility colleagues
HCW interviews	Facility manager time	Monthly	Estimated time x Average salary x 7 months internship x 618 facility managers
HCW surveys	Intern supervisor time	Monthly	Average time x Average salary x 7 months internship x 213 intern supervisors
HCW surveys	Intern supervisor travel	Monthly	Estimated monthly trips X 7 months internship x 213 intern supervisors x Average cost per trip

Table 5.6: Estimated cost of the Youth Health Africa program in 2021 USD

Cost Category	Cost Per Project Period	Cost Per Intern Per Year	Cost Per Facility Per Year	Proportion of total cost
Personnel*	$6,789,504	$5,472.10	$18,833.57	77.0%
Interns	$4,399,300	$3,545.68	$ 12,160.35	49.9%
YHA staff	$636,093	$512.67	$ 1,881.46	7.2%
Healthcare workers	$1,754,110	$1,413.75	$ 4,542.56	19.9%
Trainings & Meetings	$159,080	$128.21	$ 414.20	1.8%
Travel	$337,588	$272.08	$ 936.44	3.8%
Equipment & Supplies	$19,158	$15.44	$ 45.56	0.2%
Overhead	$1,508,275	$1,215.62	$ 4,161.29	17.1%
TOTAL	**$8,813,605**	**$7,103.45**	**$ 24,141.87**	**100%**

*Interns, YHA staff, and healthcare workers are subcategories of 'Personnel,' but percentages provided for these categories are calculated based on the total cost (not Personnel cost).
Abbreviation: YHA = Youth Health Africa.

Table 5.7: Cost for the Youth Health Africa program by actor (2021 USD)

Actor	Cost Per Project Period	Cost Per Intern Per Year	Cost Per Facility Per Year	Proportion of total cost
Non-governmental organizations*	$6,833,554.91	$5,507.60	$18,955.77	77.5%
Health facilities	$1,980,049.95	$1,595.85	$5,492.51	22.5%
TOTAL	**$8,813,604.86**	**$7,103.45**	**$24,448.28**	**100%**

***Predominantly comprised of the Youth Health Africa organization

Table 5.8. Estimated costs of Youth Health Africa program based on three sensitivity analyses (2021 USD)

	Per Intern Per Year			Per Facility Per Year			% of Total		
COST CATEGORY	**Low**	**High**	**Staggered Start**	**Low**	**High**	**Staggered Start**	**Low**	**High**	**Staggered Start**
Personnel	$3,771	$7,035	$6,227	$12,979	$24,212	$12,500	72%	80%	77%
Interns	$2,586	$4,505	$3,546	$8,901	$15,506	$7,119	49%	51%	44%
YHA staff	$513	$513	$513	$1,764	$1,764	$1,029	10%	6%	6%
Healthcare workers	$672	$2,017	$2,168	$2,314	$6,942	$4,352	13%	23%	27%
Trainings & Meetings	$128	$128	$128	$441	$441	$257	2.4%	1.5%	1.6%
Travel	$148	$397	$436	$509	$1,367	$876	2.8%	4.5%	5.4%
Equipment & Supplies	$15	$15	$15	$53	$53	$31	0.3%	0.2%	0.2%
Overhead	$1,216	$1,216	$1,216	$4,184	$4,184	$2,441	23%	14%	15%
TOTAL	**$5,278**	**$8,791**	**$8,022**	**$18,167**	**$30,257**	**$16,105**	**100%**	**100%**	**100%**

*Interns, YHA staff, and healthcare workers are subcategories of ‘Personnel,’ but percentages provided for these categories are calculated based on the total cost (not Personnel cost).
Abbreviation: YHA = Youth Health Africa.

Table 5.9: Estimated cost of scaling the Youth Health Africa program to all publicly run health clinics and centers in South Africa (2021 USD)

	Main Analysis	Sensitivity Analysis		
		Low	High	Staggered Start
Cost per facility per year	$24,448	$18,167	$30,257	$16,105
First Year				
Total estimated start-up costs	$2,347,646	$1,744,486	$2,905,428	$1,546,483
Total cost for first year	$96,253,490	$71,523,933	$119,122,565	$63,405,788
% of NDoH Budget	2.3%	1.7%	2.8%	1.5%
Steady State				
Total cost per year	$93,905,843	$69,779,447	$116,217,137	$61,859,305
% of NDoH Budget	2.2%	1.6%	2.7%	1.4%

NDoH=National Department of Health (South Africa)
Assumptions: Number of facilities = 3,841; NDoH Budget for 2021-2022=$ 4,269,165,256; start-up costs would add 2.5% to the first year's costs.

FIGURES

Figure 5.1. **Calculation of cost metrics for the Youth Health Africa program**. Calculations assume the average length of placement for an intern at a health facility was 7 months and the average engagement with a facility was 7 months.

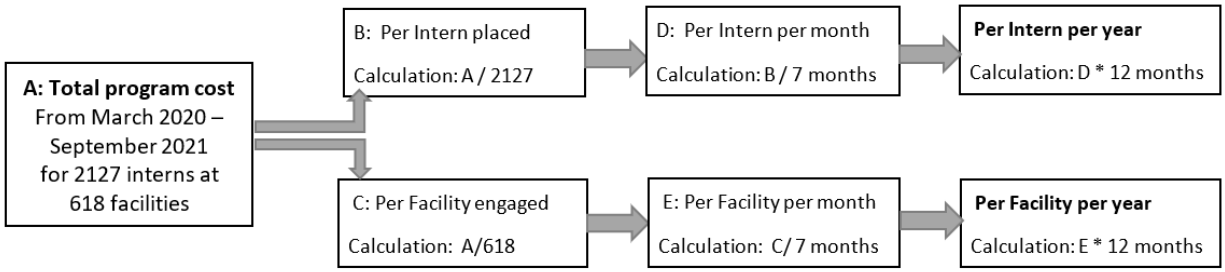
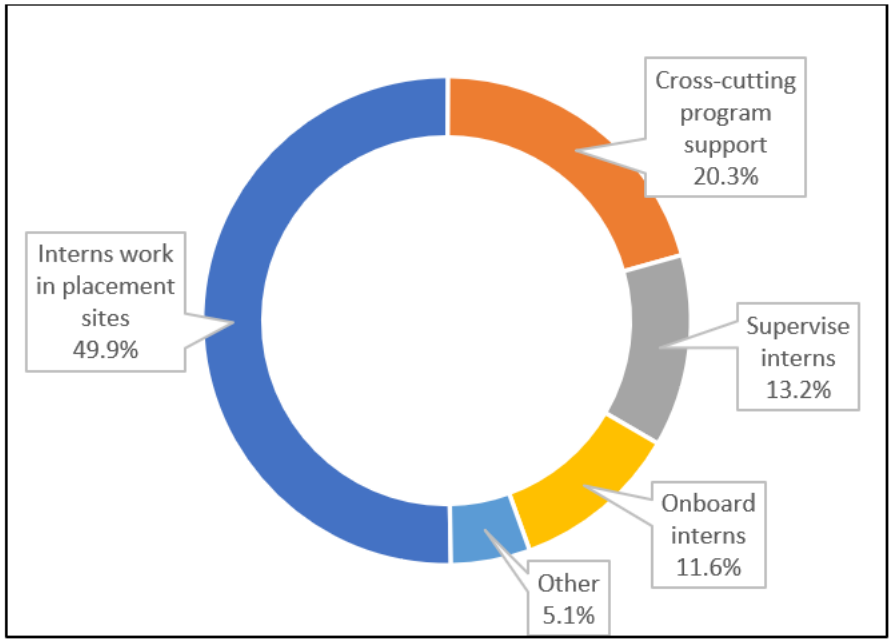
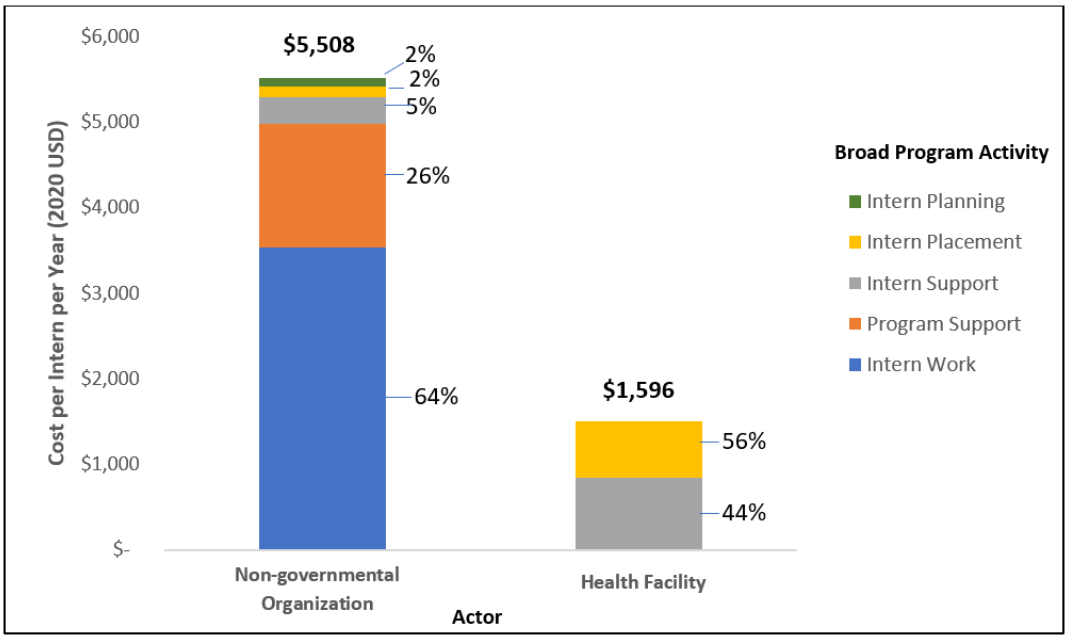


Figure 5.2: Proportion of costs per activity involved in the Youth Health Africa program.



"Other" is comprised of the following activities, comprising the following proportion of total costs of the Youth Health Arica program: provide interns professional development (2.2%), identify funding (1.1%), support host facilities (0.8%), prepare interns for post-internship (0.6%), identify health partners (0.2%), and recruit interns (0.2%).

Figure 5.3. Cost of the Youth Health Africa program by actor and activity (2021 USD)



APPENDIX A: Sensitivity analysis parameters

Table 5A.1. Parameter changes used in sensitivity analyses

COST CATEGORY	Sensitivity Analysis		
	Low	**High**	**Staggered Start**
Personnel – Interns	No change	No change	No change
Personnel – YHA Staff	No change	No change	No change
Personnel – HCW Staff			
Colleagues	Decrease time by 50%	Increase time by 50%	No change
Managers	Decrease time by 50%	Increase time by 50%	*Onboarding support:* Increase to 3 times (once per intern) *Supervision*: Increase to 12 months
Intern Supervisors	Decrease time by 50%	Increase time by 50%	Increase months supervising interns to 12
Trainings & Meetings	No change	No change	No change
Travel			
YHA staff: Overnight	Reduce to 3,000 Rand	Increase to 6,000 Rand	No change
YHA staff: Day	Reduce distance to travel to 25 km one-way	Increase distance to travel to 75 km	No change
Intern Supervisors	Reduce distance to travel to 25 km one-way	Increase distance to travel to 75 km	Increase months visiting interns to 12
Equipment & Supplies	No change	No change	No change
Overhead	No change	No change	No change

APPENDIX B: Cost by category and activity

Table 5B.1. YHA program costs per intern by cost category and activity (2021 USD)

	Cost per Intern per Year	**% of Total Cost**
Personnel – Interns	**$3,545.68**	**49.9%**
Work in placement sites	$3,545.68	49.9%
	$512.67	**7.2%**
Personnel - YHA staff	$68.29	1.0%
Identify funding	$13.96	0.2%
Identify health implementers	$11.08	0.2%
Recruit interns	$58.71	0.8%
Onboard interns	$-	0.0%
Supervise interns	$37.65	0.5%
Support host facilities	$49.10	0.7%
Professional development	$21.63	0.3%
Prepare for post-internship	$43.41	0.6%
Cross-cutting program support	$208.85	2.9%
Personnel - Healthcare workers	**$1,413.75**	**19.9%**
Onboard interns	$707.44	10.0%
Supervise interns	$706.31	9.9%
	$128.21	**1.8%**
Trainings & Meetings	$5.02	0.1%
Onboard interns	$122.96	1.7%
Professional development	$0.23	<0.01%
Cross-cutting program support		
Travel	**$272.08**	**3.8%**
Identify funding	$11.34	0.2%
Onboard interns	$49.74	0.7%
Supervise interns	$192.06	2.7%
Support to host facilities	$9.96	0.1%
Professional development	$8.99	0.1%
Equipment & Supplies	**$15.44**	**0.2%**
Cross-cutting program support	$15.44	0.2%
Overhead	**$1,215.62**	**17.1%**
Cross-cutting program support	$1,215.62	17.1%
Total	**$7,103.45**	**100%**

APPENDIX C: Healthcare worker time

Table 5C.1. Summary of time spent by healthcare workers on the Youth Health Africa facility-based youth lay health worker program, based on primary data collection among healthcare workers.

Healthcare Worker	**Onboarding**		**Routine Supervision**		**Data Source**
	Research Findings	**Estimate in study**	**Research Findings**	**Estimate in study**	
Facility Colleague	Interns require substantial upfront training which can be burdensome. Estimates on time ranged from a few days to a couple weeks. Training is one-on-one.	40 hours for first month of internship	They interact with interns continuously during work activities, and interactions are not burdensome	0 hours for remaining months of internship	Interviews (n=17)
Facility Manager	Provide an orientation to facility and more intensive check-ins with interns. Occasionally they support technical training.	2.5 hours a week for all interns for first month of internship	Occurs on an ad-hoc basis. Common to have brief everyday check-ins (e.g., 15 minutes or less) with all interns together.	1 hour per week for all interns for remaining months of internship	Interviews (n=16)
Intern Supervisor	While intern supervisors may provide training, they are not generally involved with upfront training of interns.	6 hours a week for all interns	Average time per week for all interns: 5.9 hours (SD: 7.8).	6 hours a week for all interns	Surveys (n=27)

CHAPTER 6. Conclusion

Key Findings

To the best of our knowledge, this is the first research to explore how unemployed youth can be leveraged to strengthen HIV service delivery in health facilities in sub-Saharan Africa. We evaluated the impact, acceptability, appropriateness, and affordability of implementing the Youth Health Africa (YHA) internship program in health facilities to support HIV services in South Africa. The results of this evaluation, summarized in Figure 6.1 below, were positive overall and suggest that YHA can be used to strengthen HIV service delivery at health facilities in South Africa.

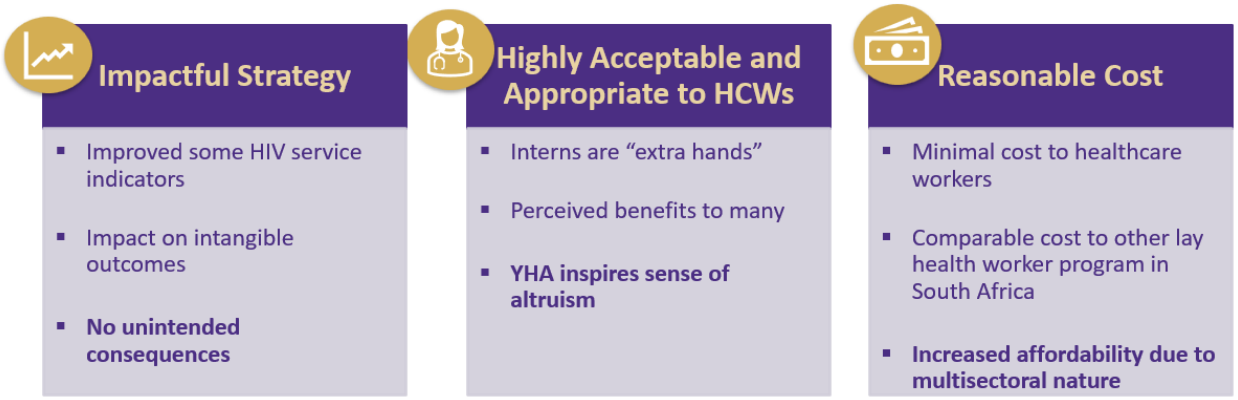


Figure 6.1. Key take-aways from our research on the Youth Health Africa program in health facilities.

Aim 1: We found YHA to have modest but positive impacts on HIV service delivery. An interrupted time series analysis (Chapter 2) and a cluster randomized controlled trial (Chapter 3) found the program likely increases HIV testing but not the number of positive cases identified. The time series analysis suggests this program may also impact new treatment initiation, but not necessarily rapid treatment initiation (within 14 days of diagnosis); the randomized trial signaled a possible increase in rapid treatment initiation, but this finding was not statistically significant. The time series analysis also indicated possible impact on retention in care, but these findings were not echoed in the randomized trial. We explore potential reasons for differences in results between studies in Chapter 3. Overall, we believe the results of the time series analysis are more reliable than the randomized trial, due to its larger sample size and more diverse sample (e.g., inclusion of facilities with a wider variety of intern numbers).

Aim 2: Interviews and surveys with healthcare workers described this program to be an acceptable and appropriate approach to bolster human resources in health facilities (Chapter 4). Healthcare workers viewed the program as mutually beneficial to themselves, interns, and patients. They described interns to be much needed "extra hands" at the facility, meaningfully contributing to HIV program tasks and bolstering clinic morale, reducing patient wait time, improving access to accurate patient data, and generally improving patient care. They also felt this program was beneficial to interns and broader society due to its focus on youth empowerment. While healthcare workers acknowledged that supervising and supporting interns could be initially burdensome, they largely found the benefits of the program to outweigh its costs. The YHA's focus on youth empowerment may make this program even more appealing to health care workers, who can be particularly motivated by altruism.

Aim 3: Finally, we found that this program could be an affordable option for expanding access to lay health workers (Chapter 5). The program's opportunity cost to healthcare workers was minimal, which echoed findings from Chapter 4. Our research suggests Youth Health Africa has a cost comparable to that of existing lay health worker programs in South Africa, although analogous data are sparse. This is important as YHA has a different goal than traditional lay health worker programs, but its focus on workforce training and youth empowerment does not appear to make it less affordable than existing approaches. If anything, YHA's focus on youth unemployment may increase the program's affordability as the program's multisectoral nature could make it appealing to a wider funder base.

Future Considerations for Program

Our research also identified factors that could help maximize the impact, acceptability, and efficiency of this program (Table 6.1). Firstly, YHA's impact on HIV service delivery may be maximized by having a greater number of interns working at a clinic. We observed a dose-response relationship between number of interns and impact on HIV service delivery; at least three interns per facility may be necessary for this program to be effective. Moreover, establishing a higher minimum number of interns to be placed per facility could also improve program efficiency, as costs for supervision are generally incurred per facility, not per intern. Secondly, the program may wish to revise HIV testing strategies to increase testing yield; the current facility-based approach has led to an increase in HIV testing but no increase in identification of positive cases. There is a need to reassess where interns are testing. There may be a need for YHA

interns to support community-based HIV testing, but we do not know how this change could be perceived by healthcare workers or community members, or how this would affect costs. Thirdly, the YHA program could retain, or perhaps even increase, its positive reception amongst healthcare workers by engaging facilities when making decisions on intern placements; ensuring clear communication about the program to healthcare workers, including emphasizing its goal to empower youth; and finding ways to decrease time healthcare workers spend training interns. Lengthening the internship period to two years could reduce the training burden while also increasing the program's efficiency.

Table 6.1. Strategies that may increase the impact, acceptability and appropriateness, and efficiency of the Youth Health Africa program

	To increase Impact	*To increase* Acceptability & Appropriateness	*To increase* Efficiency
At least 3 interns per facility	X		X
Revise HIV testing strategies	X		
Lengthen program to 2-year internship		X	X
Engage HCWs when deciding on placements		X	
Refined communication with HCWs		X	

Impact on Public Health

The results of this research provide policy and decision-makers with a new option to strengthen HIV service delivery in understaffed health facilities. The YHA approach appears to be yet another strategy that can support care for people living with HIV and thus reduce spread of HIV. Even if the impact of YHA on HIV care and treatment is minor, this program could still be beneficial to health systems. While there are numerous approaches to lay health worker programs, this is the first time a youth employment program has been considered as a way to bolster the health workforce. Healthcare workers' resounding acceptance of this program suggests this approach could be helpful wherever lay health workers could be used to support care in health facilities. This program could offer a novel path to increase human resources for health in facilities, which could lead to improved healthcare worker retention and quality of care.

This program may also be able to support community-based lay health worker programs (e.g., community health workers), but additional research would be needed to understand if or how this model could be adapted to successfully fit a community-based setting as we did not study patient perspectives of YHA interns (e.g., Would people in communities trust interns like they would traditional community health workers?). Similarly, we did not assess the impact this project had on the interns or youth unemployment, but we do know that the program had provided job training through internships to more than 3,000 interns by the end of 2021. The literature suggests youth employment and health are connected (1,2), but further research is necessary to determine exactly how YHA may affect the youth interns immediately following their internships as well as in their long-term careers.

Finally, the results of this research may be used to impact public health by expanding funding opportunities for lay health worker programs, which are currently underfunded (3). The multisectoral nature of this program could help galvanize funding sources that are not commonly used in global health, particularly entities with a designated interest in increasing youth employment, such as the private sector, development finance institutions (e.g., African Development Bank), or governmental ministries that focus on employment and labor. This could identify extra resources to bridge gaps in human resources for health, while enabling expansion of HIV programs and youth workforce training.

Limitations

Our research was subject to several limitations described in earlier chapters for each individual study, but there were overarching limitations that should be mentioned. Firstly, our research was limited in scope. We did not consider YHA from the intern or societal perspectives, thus we have not captured the full impact or costs of the program. We hypothesize that YHA could have positive impact on youth and broader society as its primary goal is youth empowerment, but additional research would be necessary to explore this. Similarly, we did not study patient perspectives of the YHA program, thus we do not know how patients perceive receiving support or care from youth interns; this has implications on our ability to understand if this model can be adapted for community health workers. Secondly, our research was not designed to identify the core components or causal mechanisms for this intervention, which limits the ability of our work to inform effective scale-up or adaptation of this approach. Scale-up or scale-out of successful interventions can fail if there is uncertainty around how the intervention works (4). There is

reason to believe this model could be scaled to new contexts, but careful consideration is needed to understand when scaling may work and what needs to be in place for it to work. For example, we are curious if this model can be successfully adapted to support other facility-based health programs (e.g., tuberculosis or antenatal care) or community health worker programs. Additional research is needed to increase our understanding of the core components necessary for this intervention (e.g., what is necessary for successful supervision) to improve scale-up and scale-out as this program moves to new settings.

Moving Forward

Our research suggests that the novel YHA internship program may be an impactful, acceptable, appropriate, and affordable program to improve HIV service delivery and bolster human resources for health. While we recognize that more research would benefit scale-up and scale-out of this intervention, the results of our research suggest the youth intern approach can be a powerful, multisectoral tool to support health system strengthening, specifically for HIV programs, in South Africa.

The results of this research can be used by decision and policy makers to support planning and scale-up of YHA or a similar approach. The YHA program has grown rapidly in South Africa from private-sector funding, but there is potential for the program to further expand if relevant government partners (e.g., the National Department of Health or the Youth Employment Service in the Office of the Presidency), and development finance institutions (e.g., the African Development Bank) are engaged. There could also be interest to expand this program to other low- and middle-income countries which face challenges similar to those of South Africa with respect to HIV, human resources for health, and unemployment. Finally, this research could also inform scale-out to other health programs that rely on lay health workers, including community health workers (e.g., tuberculosis or Maternal and Child Health programs). As this program expands, we call for additional research to understand the core elements needed for success; the effect of the program on broader health system performance; and the impact of this program on youth.

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