

# Predictors of COVID-19 vaccination among OVC and AGYW in Eswatini

By

Valeria Navarro Galarza, MSc Candidate

Georgetown University

Washington, DC

Pact Eswatini

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## Abstract

**Background:** COVID-19 vaccination rates in Eswatini have remained under the expected threshold. Understanding the COVID-19 vaccine uptake predictors is essential to differentiate the messaging targeting its population to meet the national vaccination goals through a massive COVID-19 vaccine campaign. We identified the prevalence and predictors of COVID-19 vaccination among the beneficiaries of the Insika Project in Eswatini.

**Methods:** Retrospective cohort study from secondary data of beneficiaries enrolled in the Insika Project in Eswatini since 2018. The main exposure was the registry of COVID-19 vaccine offer through the Insika vaccination campaign since April 2021 and the main outcome was the complete COVID-19 vaccination until the end of June 2022. We conducted univariate analysis for vaccination rates by type of beneficiary and multivariate regression analysis adjusted for confounders; the final model was built backward stepwise starting with all variables theoretically important and with  $p\text{-value} \leq 0.05$  in bivariate analyses. We present adjusted Odds Ratios (aOR) with 95% confidence intervals (CIs).

**Results:** In 6 562 beneficiaries, the median age at end of follow-up was 18.2 (ICR: 15.8-22.1), 78.3% were female, and 51.1% were vaccinated for COVID-19. Of the vaccinated ones, 32.9% were 15-17 years old, 76.5% were female, 35.6% were OVCs, 40.5% were from Lubombo region and 33.4% were from Bantwana IP. The final model included region, IP, pregnancies, caregivers' COVID-19 vaccination, household socioeconomic status, GBV cases, receiving protection services, receiving health services, and life mentorship beneficiaries; pregnancies, urban region residents, and Bantwana, Cabrini, and Young Heroes IPs were independently and significantly associated with COVID-19 vaccination. On the opposite, caregivers' COVID-19 vaccination, caregivers' self-employment, and receiving protection and life mentorship services were independently and significantly associated with no vaccination. The predictors differ by type of program when the model was segregated for each of them.

**Conclusion:** Among the Insika beneficiaries in Eswatini, pregnancy and urban places of residence were positive predictors of COVID-19 vaccination. Having caregivers vaccinated for COVID-19 and unstable household economic status had the opposite effect, evidencing the social burden of the COVID-19 pandemic in a vulnerable population. Different messaging targeting this specific population may improve COVID-19 vaccine uptake in Eswatini.

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## Acronyms and abbreviations

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Acronym/abbreviation	Definition
AGYW	Adolescent Girls and Young Women
BM	Business Mentor
C/ALHIV	Children and Adolescents Living with HIV
CVM	Community Vaccine Mobilizers
DOW	Dreams on Wheels
DREAMS	Determined, Resilient, Empowered, AIDS-free, Mentored and Safe
ES	Economic Strengthening
FP	Family Planning
HEI	HIV Exposed Infants
HV	Home Visitor
IP	Implementation Partner
LM	Life Mentor
MOH	Ministry Of Health
MSF	Médecins Sans Frontières (Doctors without Borders)
OVC	Orphan and Vulnerable Children
PBFW	Pregnant and breastfeeding women
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PLHIV	People Living with HIV
RCCE	Risk Communication and Community Engagement
GBV	Gender-Based Violence

SI

Strategic Information

USAID

United States Agency for International  
Development

VPDs

Vaccine-Preventable Diseases

WORTH

Women Organizing Resources Together

## Definition of terms

- **Active beneficiary:** person enrolled in the Insika project that has received at least one service in the period from 2018 until June 2022 and has not graduated during that time.
- **Adolescent Girls and Young Women:** females aged 10-24 years (1). The interval of the 25–29-year group was added in Eswatini as it is a setting in which HIV incidence and risk are high. The USAID program targeting AGYW in Sub-Saharan Africa is called DREAMS. The main goal of the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) partnership is to reduce the HIV incidence among AGYW. Implemented since 2015, the DREAMS project provides women with the necessary skills to improve their reproductive health, social empowerment and protection, and tools to reduce HIV risks (2). It involves three components: HIV prevention – Life Mentorship program, Youth Livelihoods ES program, and community leadership and engagement.
- **Caregiver:** either a biological parent or an adult that lives with the child on a daily basis. The Insika project enrolls two caregivers: the primary and secondary. The primary caregiver is categorized as the one who lives with the child full-time, considering that the biological caregiver is not necessarily living with the child.
- **Orphan and Vulnerable Children (OVC):** those facing adverse effects due to HIV consequences, followed until 19 years old. USAID defined them as “children who are living with HIV, living with caregivers who are living with HIV, orphaned, at risk of becoming infected, or a combination of these factors” (3). For this study, the OVC target populations are children and adolescents living with HIV, children of people living with HIV, children from child-headed households, children of female sex workers, children who are survivors of abuse, children who have dropped out of school, HIV exposed infants, and pregnant teens and teen mothers. They receive four types of services: health, education, protection, and stability. The last two include obtaining a birth certificate and positive parenting orientation. The OVC program trains HV who are members of the community to provide comprehensive family-based support for OVC and their households.
- **OVC DREAMS:** DREAMS beneficiaries that receive secondary services from the OVC program. The program provides OVC services to those DREAMS AGYW who meet other vulnerability criteria. The services are synergized with OVC for education subsidies, caregiver interventions like WORTH services groups (SLG targeting only caregivers) and positive parenting education, and protection for GBV. OVC and DREAMS overlap to provide a complete package of services to the beneficiaries pending the needs identified by the LMs, BMs, HVs, or other community cadre personnel.

- **Tinkhundla:** Eswatini's constituencies and lowest government administrative levels. Inkhundla applies to the singular term. The country has 59 Tinkhundla in total.
- **Vaccinated beneficiary:** client is fully vaccinated for COVID-19 with all the required doses pending on the type of vaccine used. Boosters are not considered.
- **Zionism:** branch of Christianity in Southern Africa that incorporates African beliefs in its practice.

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# **1. Introduction**

## **1.1. Overview**

OVC and AGYW in Eswatini are more vulnerable to being directly or indirectly affected by external stressors like the consequences of the COVID-19 pandemic. The Eswatini government, together with external donors, has made efforts to increase the COVID-19 vaccine uptake among this population; however, the rates remain below the expected threshold in 2022. The recognition of the predictors of COVID-19 vaccination in the vulnerable population from Eswatini will assist the vaccination campaign to improve the strategies and create more demand for the service in order to diminish their risk of vulnerability.

## **1.2. Background**

Pact Eswatini, in partnership with USAID and PEPFAR, is implementing the Insika ya Kusasa -or Ready, Resourceful, Risk Aware (Triple R)- project for the period 2018-2023 which aims to prevent new HIV infections and reduce vulnerability among OVC and AGYW in Eswatini. The main goal of the Insika project is to build socio-economic resilience to the impact of HIV among key groups and to increase the uptake of high-impact services for HIV, sexual and reproductive health, family planning, and gender-based violence. The OVC program in Eswatini provides multidisciplinary support to the children to improve their health, education, and overall well-being besides the provision of HIV services for care and prevention (3).

Since the beginning of the COVID-19 pandemic, Pact, in collaboration with the Minister of Health, has implemented a COVID-19 response program as part of the project to educate the community about the new virus and enhance vaccine uptake in the eligible population. COVID-19 vaccinations have been progressively available in Eswatini since March 2021. However, until June 30<sup>th</sup>, 2022, only 31.6% of the Swati population has been reached with vaccine uptake nationally. Considering the government's goal of targeting a 70% vaccination rate for the overall population in Eswatini, the uptake has been slow and different by population groups -being higher in the elderly and much lower in the youth-. There is a lack of knowledge about predictors of COVID-19 vaccine uptake in the youngest population of the country.

## **1.3. Problem statement**

Despite the implementation of the COVID-19 response program and the availability of vaccines for the Eswatini's citizens from 12 years old, only 34% of the target population of Insika beneficiaries received the complete scheme of the vaccines by June 2022. The little known about the vaccination predictors in this population impedes differentiation of the messaging interventions to increase vaccine uptake. It is imperative to understand what the predictors for uptake are to improve the strategies by targeting those in the population who are more likely to vaccinate and those who are not with different messaging interventions.

#### **1.4. Overall research question**

For that reason, this research aims to describe the prevalence and the predictors of COVID-19 vaccination among the beneficiaries from the different Insika programs and to compare these predictors by beneficiary group type.

#### **1.5. Rationale and significance for the study**

Pact is supporting the government of Eswatini to increase vaccine uptake through the COVID-19 response database not only for the Insika beneficiaries but for the whole Swati population at each Inkhundla in the country. Describing the characteristics of those Insika beneficiaries who have been vaccinated and those who have not and identifying the predictors of vaccine uptake by type of program will provide useful information to enhance or modify the strategies that have been implemented among the Insika beneficiaries. Given the national support Pact is providing to the government, the obtained information will collaborate with the broader vaccine uptake national goal beyond the Insika one. Furthermore, this study contributes novel data about predictors of COVID-19 vaccination in the vulnerable population living in low-income countries, such as Eswatini.

## **2. Study objectives**

The goal of this study is to identify the prevalence of vaccination and predictors of vaccination of the beneficiaries from the OVC and DREAMS programs from Pact in Eswatini who have been vaccinated for COVID-19 in order to enhance vaccine uptake by improving the current engagement and educational strategies in the short-term. To achieve those goals, this study has the following main and secondary objectives:

### **Main objective**

1. To identify the predictors of COVID-19 vaccination among Insika Ya Kusasa beneficiaries.

### **Secondary objective**

2. To compare the predictors by beneficiary group type (OVC vs DREAMS VS OVC DREAMS)
3. To describe the prevalence of COVID-19 vaccination by age, sex, Inkhundla, and implementation partner (IP).

### **3. Literature review**

#### **COVID-19 in vulnerable populations**

COVID-19 has impacted health systems worldwide at all levels. As of August 16, 2022, there has been 587,455,360 confirmed cases, 6,429,430 deaths and 4,857,273,828 persons fully vaccinated globally. Africa accounts for 1.6% of the reported confirmed cases and 2.7% of the reported deaths (4). The management of COVID-19 disease has required a multidisciplinary approach to treat the infection as it affects almost every organ of the human body, principally the pulmonary, cardiovascular, and nervous systems (5). Specific populations have been described to be more predisposed to severe forms of the disease. People with cardiovascular diseases, cancer or immunosuppression diseases, and the elderly are at higher risk of severe COVID-19 and death. Several studies reported that populations living at lower socioeconomic status and conditions have the worst economic and health consequences if their households are affected by COVID-19, turning them more vulnerable to catastrophic outcomes (6-8).

In the case of people living with HIV (PLHIV), it is presumed that those virally suppressed and on ART have the same risks for COVID-19 as those who are HIV-negative. However, PLHIV with CD4 counts less than 200  $\mu$ L, those who are not suppressed or have opportunistic infections are considered at-risk populations and have poorer outcomes. The rates of ICU admission among this population vary between 3-22% (9), much more than the average for the rest of the population. A recent study from WHO established that HIV is an independent risk factor for severe COVID-19 and in-hospitalization mortality (10). In addition, PLHIV has a higher incidence of multiple neoplastic, cardiovascular, and neurological comorbidities which increases the risk of severe outcomes due to COVID-19. One study reported multimorbidity in two-thirds of patients with HIV and Sars-Cov-2 coinfection, evidencing the higher risk among the HIV population with more than two comorbidities (11). These data highlight the importance of prioritizing vaccination among the population affected with HIV.

#### **Impact of the COVID-19 pandemic on health services delivery**

The worldwide mobility restrictions at the beginning of the pandemic had strong repercussions on delivering health services for chronic diseases like HIV. The negative impact of Sars-Cov-2 infection among vulnerable populations is not completely measured, yet. Differentiated service delivery (DSD), case-finding, ART provision, and monitoring services for pregnant and breastfeeding women (PBFW), HIV exposed infants (HEI), children/adolescents living with HIV (C/ALHIV), and orphans and vulnerable children (OVC) adapted to the new measures in order to continue providing the HIV services (12) by incorporating new technology and innovative strategies, although the overall success of these adaptations has not been fully described, yet. As of 2020, 1 500 000 people were newly infected with HIV, less than in 2019 (13). However, the rates

for 2021 have not yet been published to properly measure the impact of the pandemic after two years of its appearance.

In Sub-Saharan Africa, different methods were implemented to ensure the provision of HIV services without disruptions during the mitigation restrictions adopted by the governments of the region. First, the eligibility of DSD was expanded for HIV treatment. The guidelines in Eswatini were adapted to provide multi-month dispensing (MMD) from ART initiation, including pregnant and breastfeeding women and children above the age of two years. Second, the MMD was extended, and the clinical consultations were reduced. Eswatini extended the maximum duration to 6 months, reaching 103 sites and 25 000 patients in March 2020. Third, community ART delivery was implemented. The government of Eswatini designated leaders in the community to collect drug refills for all the beneficiaries in their community. Fourth, the services integrated the provision of treatment for other comorbidities and family planning. In the case of Eswatini, the services provided FP services with the ART refill (14).

In the WHO Africa region, the essential health services delivery was continuously disrupted because of the mitigation measures, the misinformation about COVID-19 among the population, and the weak surveillance and diagnosis services in the region. These resulted in an underreporting of Sars-Cov-2 confirmed cases and deaths. One model estimates that the total of confirmed cases from 2020 until December 2021 is 505.6 million, in contrast to the 7 million reported for the same period, which corresponds to 1.4% of the real estimates. For COVID-19 deaths, the estimation is 439 500, in comparison to the official reports of 155 248 deaths. In the same model, for Eswatini, the authors estimated that only 11% of the real number of confirmed cases and 98% of the deaths have been reported (15). This is evidence of the fragility of the health system in the region. The real consequences of the COVID-19 pandemic cannot be properly measured if the numbers do not reflect the real impact of the disease.

### **Eswatini's response during the COVID-19 pandemic**

With 70% of its population living in rural settings, Eswatini has 39.7% of its population living under the international \$1.90 poverty line (16). Its medium human development index (HDI) of 0.611 locates it at the 138 position out of 189 countries (17). It also has a Gini index of 54.6, evidencing the high inequalities in the country (18). With a GDP per capita of 3,424.3 in 2020, an economic increase of just 2% by 2021, and a health staff-population ratio of 1.62 per 1000 population - below the WHO recommendation- (16,19,20), the pandemic demands exceeded the capacity of Eswatini's health system, occasioning its collapse without enough oxygen provision and burn-out of the medical staff (20). After the first COVID-19 confirmed case in March 2020, the government declared a state of emergency and total lockdown of the country. The already low socioeconomic conditions, unemployment, food insecurity, and weak surveillance system were worsened by these measures that tried to diminish the rates of the virus. Even more, as shown in the estimated COVID-19 confirmed cases model, the official country data is not reliable because

the high rural population does not have a close health facility where they can report its symptoms and get a confirmatory test. Nevertheless, it was expected that most of the cases were located in the urban and peri-urban regions of the city, the most populated, and therefore, with less probability of complying with social distancing (21). The United Nations reported that the vulnerable populations in Eswatini were considerably more affected by the COVID-19 pandemic, including women, children, extremely poor and near poor, persons with TB, and people affected and infected by HIV (22). In addition to the pandemic consequences, the social unrest in 2021 in the country increased the risk of violence and vulnerability for the youth (23), enhancing the instability Eswatini was already facing.

Considering the impact of the pandemic in Sub-Saharan Africa and Eswatini, prevention measures are imperative to hinder more negative consequences among the vulnerable population of the region. Until now, there is no successful treatment for either mild, moderate, or severe cases of COVID-19. The use of masks, social distancing, and vaccination are the only measures that have proved to prevent infection and development of symptoms, respectively.

### **COVID-19 vaccination in Eswatini**

Like most countries in Africa, Eswatini did not meet the 40% full primary immunization goal of the WHO by the end of 2021 (24). In contrast, it had only 34.2% of its population fully vaccinated and 746 363 vaccine doses administered by the first week of August 2022 (4). As of our knowledge, rates of PLHIV, OVC, AGYW, and key populations vaccinated against COVID-19 are not reported, yet. Organizations like MSF and Pact have been working in the country supporting the government's national vaccination campaign to reach the last mile population (25), however, the rates have not had a significant increase. By July 2022, 44.44% of the population with the first dose received their second dose, including those vaccinated with Janssen, considering the current recommendations of two doses for this vaccine. The mean age of those fully vaccinated is 40.5 years old, whereas the mean for those with only one dose is 33.2 years old.

In general, Africa has faced several problems with the supply chain of COVID-19 vaccines. Insufficient personnel capacity, infrastructure, funding, unequal vaccine access, and lack of needed tools for vaccination provision are some of the reasons that explain why the continent has not achieved the expected vaccination goals until the first semester of 2022 (24,26). The COVAX initiative failed to deliver a sufficient number of vaccines to the region that still requires receiving 793 million more doses in order to reach 40% of the population. Despite all the efforts, by the end of 2021, only 2.5% of the African population was vaccinated against COVID-19 (27).

Another important factor that deploys the low rates in Eswatini is the hesitancy and misinformation about the vaccines. Even though low-middle income countries have overall accepted the inclusion of vaccines in their health systems in comparison to high-income countries,

Eswatini has faced massive misinformation spread about the administration of this new vaccine, most of them based on conspiracy theories and myths. The most common reason found for hesitancy in LMIC was side effects, almost spread by media coverage (28), consistent with a report from Eswatini that confirms its population is not vaccinating because of negative perceptions about safety and effectiveness, religious beliefs, and myths expanded by social media and lack of trust to the government (29). Educational programs with community health workers and other main stakeholders are needed to enhance the trust in the health system, especially for vulnerable populations that are at higher risk of direct and indirect consequences due to the Sars-Cov-2 infection.

### **COVID-19 vaccination in vulnerable populations in Eswatini**

A longstanding health issue in Eswatini is the high rate of HIV, with an overall prevalence of 27% in 2020. Being the first country in Africa (and the second worldwide) to achieve the 95-95-95 goals (30) gives the country a responsibility to maintain and improve those records, even during the COVID-19 pandemic. Overall, the rates of HIV infection are higher in women of all ages. Young women (15-24 years old) have a prevalence of 12.2% -higher than men of the same age- and children (0-14 years old), an incidence of 10 by 2020 (31,32). AGYW are facing the highest prevalence and incidence rates, making them more vulnerable to external shocks -like COVID-19's direct and indirect consequences- that can worsen their circumstances. This also affects orphan OVC, who are more exposed to HIV and socio-economic negative effects. The country made a lot of efforts since the beginning of the pandemic to protect vulnerable populations against COVID-19 while maintaining their HIV retention in care and prevention measures.

As a vulnerable population, preventive measures for COVID-19 need to be strengthened to prevent them and their households from the severe form of the disease or catastrophic socioeconomic consequences that are a result of disease sequelae, or the lockdowns implemented to mitigate the infection spreading. For instance, neighborhood care points (NCPs) from rural communities for OVCs were closed, averting the supply of food, psychological support, and program funding to this population (33). Different adaptations of HIV services provided to these populations were suggested, mostly based on virtual monitoring through SMS, calls, and outdoor activities in the communities (12). The same rationale was implemented for children schooling while the schools were closed. However, the difficulties in rural areas accessing technological devices are barriers to successfully implementing these measures.

The safest way to protect vulnerable populations and ensure the continuation of support programs is by vaccinating them for COVID-19. For that reason, in order to avoid the shutdown of these services and other repercussions of the pandemic, COVID-19 vaccination has been included in the OVC and DREAMS projects of Pact Eswatini and supported by USAID to offer them further protection and to promote vaccine uptake in their households. The benefits of

vaccinating children have been widely reported. It protects them against severe and long forms of COVID-19, against Pediatric Inflammatory Multisystem Syndrome temporally associated with SARS-CoV-2 (PIMS-PS), prevents community transmission, and avoids indirect harms such as school and other support services closures (34).

Currently, the availability of vaccines in Eswatini through international donations and local procurements has made it possible to supply OVCs and AGYW with COVID-19 vaccination. Until the publication of this study, three vaccines have been approved and are available for free in Eswatini: Pfizer /BioNTech, Janssen (Johnson & Johnson), and Oxford/AstraZeneca (35). The first batch received were AstraZeneca vaccines sent by the COVAX facility in March 2021. Subsequently, it received Janssen donations from the United States and by the end of 2021, the country was procuring its own vaccines in addition to the donations, although the process was halted because of the slow vaccination rates in the population (36) despite the massive national campaign. Until March 2022, only 34% of the target population of OVCs and DREAMS beneficiaries, including their caregivers, has been vaccinated.

### **COVID-19 vaccine uptake**

Several evidence-based strategies have been suggested to increase COVID-19 vaccine uptake worldwide. The CDC from the United States established twelve strategies that should be implemented within the community, including motivational interviews and home-delivered vaccinations (37). On the other side, the WHO stated interventions based on the Behavioral and Social Drivers Theory framework, such as community engagement and massive education campaigns (38). Most of them have been used by the COVID-19 response team in Eswatini through the IPs, including door-to-door education, community visits, follow-up visits, vaccine offer, and installment of community vaccine sites, plus RCCE and Health Mobile App support. Nevertheless, the vaccination rates in the country have not achieved the national goals by 2022 mid-year. It is imperative to determine the context, beliefs, and triggers of the target population that can predict the most suitable strategy to increase the uptake of COVID-19 vaccination in the country.



## **4. Methodology**

### **4.1. Study Design**

We developed a retrospective cohort study based on the secondary data obtained from the COVID-19 response database of the Insika project in Eswatini. The main exposure was beneficiaries receiving both vaccine education and vaccine offer by the CVMs and HVs. The main outcome was the complete COVID-19 vaccination of the beneficiary until the end of the follow-up period.

### **4.2. Study Setting**

COVID-19 vaccine is available for Swati and non-Swati citizens in Eswatini from 12 years old and above; having a national ID is not mandatory for vaccination. Since March 2021, the Insika project is contributing to the COVID-19 response in the country by strengthening vaccine technical assistance, deployment, and increasing uptake to both OVC and non-OVC households in the country 59 Tinkhundla. This project modification accounted for the extension of the implementation period until 2024.

The Pact Eswatini COVID-19 response is supporting the Minister of Health by expanding the COVID-19 information dissemination, creating demand for the vaccine, and contributing to the increase in vaccine service uptake. Pact currently works with eight community-engaged Implementing Partners (IP) and one clinical partner. They are providing technical assistance to the Risk Communication and Community Engagement (RCCE) national teams, recruiting Inkhundla-based community vaccine mobilizers like religious or traditional leaders to enhance community engagement, and managing the Health Alert Application digital platform. The IPs have trained the CVMs to approach the communities through door-to-door and outdoors conversations providing education about COVID-19.

The present study was conducted with the information of beneficiaries from the 23 Pact Tinkhundla distributed across all four regions of Eswatini where OVC and DREAMS programs are implemented. For them, COVID-19 education and vaccine information were provided at household level by Home Visitors and Community Vaccine Mobilizers. After the vaccine offer and pre-registration, the mobilized beneficiaries were vaccinated by teams of health professionals in mobile sites supported by the government and PEPFAR that are installed periodically at strategic spots within the community area. CVMs periodically make follow-up calls to the registered beneficiaries for reminders of appointment or date for second dose.

### 4.3. Target and study populations

The target population were the beneficiaries receiving COVID-19 vaccine education and vaccine offer from the Insika project for the period April 1st, 2021, to June 30, 2022, corresponding to the end of the Q2 of Fiscal Year 2022.

#### 4.3.1 Inclusion Criteria

Any OVC and DREAMS beneficiaries ever enrolled in the program until June 30, 2022, eligible for vaccination according to national guidelines from 12 years old until 29 years old.

#### 4.3.2 Exclusion Criteria

OVCs and DREAMS beneficiaries who did not receive vaccination offer from CVMs or Home Visitors.

### 4.4. Sampling strategy and size

#### 4.4.1 Sampling strategy

In this study we did not consider a sample, we included the entire data population of potentially eligible participants according to the inclusion and exclusion criteria identified in the 2021-2022 period.

### 4.5. Data collection

#### 4.5.1 Variables

The following variables were considered for the analysis, based on general demographics of the population and main outcomes from each program of the Insika Project. They were extracted from the CommCare database from the different programs and merged into one database.

Independent variables:

<b>Variable</b>	<b>Type of variable</b>	<b>Operational definition</b>
<b>Case ID</b>	Qualitative nominal	Unique code assigned for each beneficiary
<b>Age</b>	Quantitative discrete	Age of the beneficiary by June 30, 2022
<b>Sex</b>	Qualitative nominal	Biologic sex of the beneficiary
<b>Region</b>	Qualitative nominal	Region where the beneficiary is located at the moment of the interview, classified by Inkhundla

<b>Type of program</b>	Qualitative nominal	Program assigned to the beneficiary at enrollment that could be either OVC, DREAMS or OVC-DREAMS
<b>Possession of national ID</b>	Qualitative nominal	Number of beneficiaries with correct National ID registry
<b>Implementation partner</b>	Qualitative nominal	IP assigned to the beneficiary at the moment of the interview
<b>Household socioeconomic status (occupation)</b>	Qualitative nominal	Occupation of the caregiver at the moment of the interview.
<b>School enrollment status</b>	Qualitative nominal	Beneficiary enrolled or not in school at the moment of interview
<b>Active beneficiaries</b>	Qualitative nominal	Beneficiaries currently active in any of the Insika programs at the moment of the interview
<b>Graduation of the program</b>	Qualitative nominal	Beneficiaries who were graduated from the program at the moment of the interview
<b>Pregnancy</b>	Qualitative nominal	Pregnancy of the beneficiaries at the moment of the interview
<b>Children</b>	Qualitative nominal	Beneficiaries who have children at the moment of the interview
<b>HIV status</b>	Qualitative nominal	Seropositive or seronegative at the moment of the interview
<b>Viral load</b>	Qualitative nominal	VL outcome of HIV positive beneficiaries: suppression, no suppression or no VL
<b>Linkage to services provided by DREAMS</b>	Qualitative nominal	Beneficiaries receiving YL or LM services, and the ones within each service
<b>Linkage to services provided by OVC</b>	Qualitative nominal	Beneficiaries receiving education, health, protection or referral services, and the ones within each service
<b>Caregiver marital status</b>	Qualitative nominal	Marital status of the primary caregiver of the beneficiary at the moment of interview
<b>Caregiver vaccination</b>	Qualitative nominal	Caregiver fully vaccinated for COVID-19 at the moment of the interview
<b>Caregiver life status after COVID-19 waves</b>	Qualitative nominal	Caregivers who passed away during COVID-19 period

<b>Household socioeconomic status during COVID-19 era (occupation)</b>	Qualitative nominal	Occupation of the caregiver at the moment of the interview made during the COVID-19
<b>Caregiver HIV status</b>	Qualitative nominal	Caregiver seropositive or seronegative at the moment of the interview
<b>GBV case</b>	Qualitative nominal	Beneficiaries identified as a GBV case, either current or past
<b>Abuse type</b>	Qualitative nominal	Type of abuse if present: emotional, neglect, physical, sexual, or other

Dependent variable:

<b>Variable</b>	<b>Type of variable</b>	<b>Operational definition</b>
<b>Vaccination status</b>	Qualitative nominal	Beneficiary full COVID-19 vaccination, pending of the doses applicable for the vaccine that was used.

#### 4.5.2 Data sources

We generated a database from the data sets of OVC and DREAMS programs from the Insika project. We considered all the enrolled beneficiaries since the beginning of the program in 2018 until June 30, 2022, who were either currently active, graduated or transferred to other IP that are not under Pact’s jurisdiction. Those beneficiaries who died in the study period were excluded. The merged data included general demographic information, including sex, age, name of Inkhundla, implementation partner, occupation, and marital status as well as specific indicators such as HIV status, school enrollment, vaccination status, pregnancies, gender-based violence, caregivers’ vaccination status, among others mentioned in the previous section.

#### 4.6. Data management and storage plan

The datasets were imported to Stata/BE 17.0 for the analysis. Each observation for each client was managed by their unique client ID to preserve their confidentiality. The Pact strategic information (SI) team, who are in charge of the monitoring and evaluation of the collected data, stores the datasets in secure electronic systems with backups. The final database did not include the variables name, address, telephone and national ID. The authors of this study are the only ones with access to this database.

#### **4.7. Measures to ensure accuracy of data**

The data was extracted from the CommCare app used by the IPs of the COVID-19 response strategy of Pact. The discrepancies and missing information were either automatically or manually cleaned by the SI team and principal investigator, who extensively reviewed the data before including it in the database. Further discrepancies after the cleaning process were manually reviewed by each program team (DREAMS or OVC) for double-checking with the IPs and corrected if necessary.

#### **4.8. Data analysis**

We performed the descriptive analysis of the demographic variables and the program's outcomes variables overall and by vaccination status. For the data description, we used measures of central tendency for the continuous variables such as median, and dispersion measures such as interquartile range. For the categorical variables, we used frequencies and percentages. The tables and graphics employed were histograms for the interval variables, frequency tables for dichotomic variables, and bar graphics for nominal variables.

To evaluate the association between the main exposure receiving vaccine offer and the main outcome full COVID-19 vaccination, we used chi square tests for categorical variables and vaccination status and t-test for continuous variables. The association was also evaluated by service received (DREAMS vs OVC vs OVC DREAMS). The statistical significance level was less than 0.05.

We developed a logistic model of multivariate regression analysis for the outcome variable by backward stepwise using the statistically significant associations from the bivariate analysis to identify the predictors of vaccination for the whole sample and separated by beneficiary group type, adjusted by confounders. For the secondary objectives, we described the percentage of beneficiaries for each of the independent variables by vaccination status.

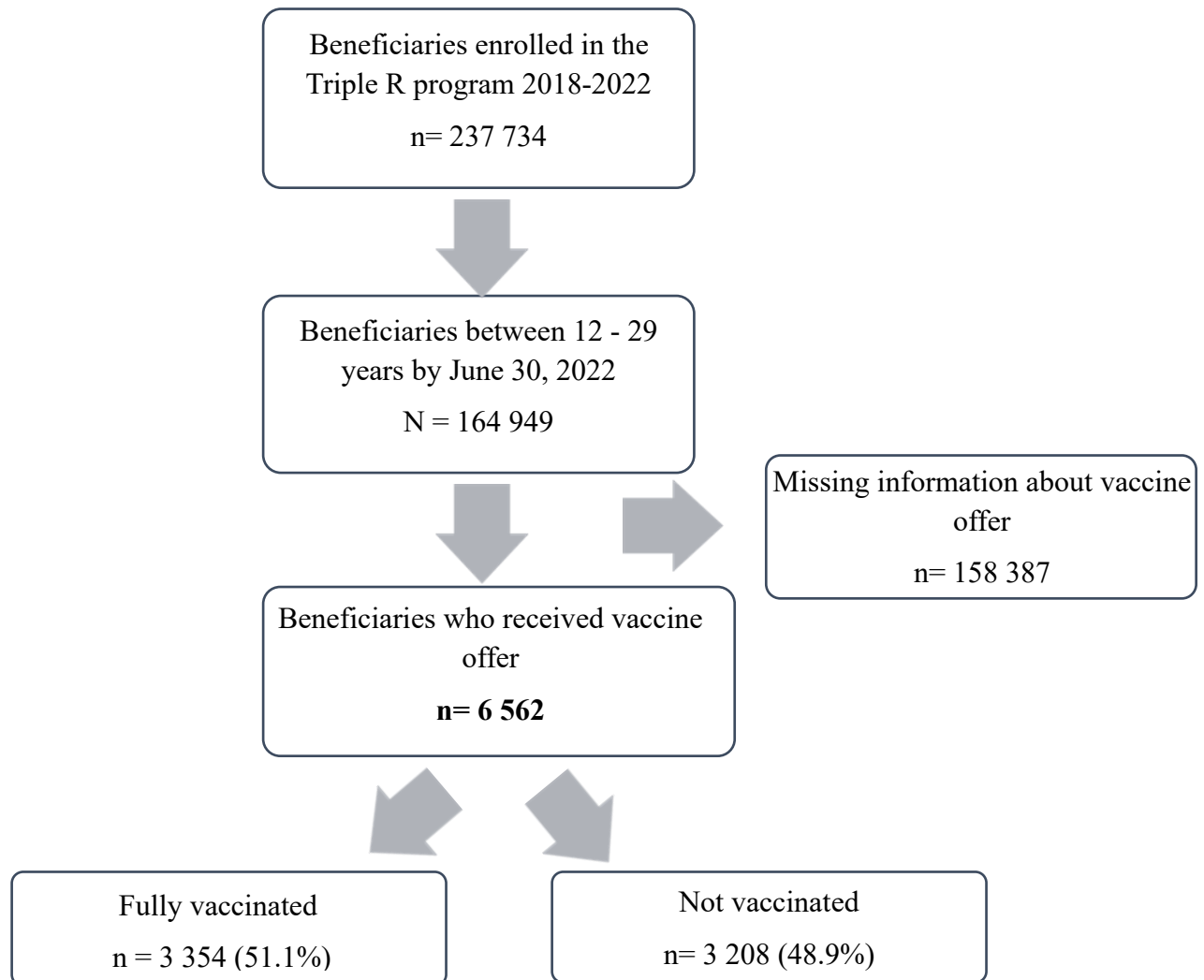
#### **4.9. Ethical Considerations**

The Triple R project implementation and its subsequent data analysis was reviewed and approved by the National Health Research Review Board (NHRRB) and the Minister of Health of Eswatini. All the investigators complied with training in research in human beings and followed good ethics and data practices for the development of the study and maintenance of confidentiality of the beneficiaries.

## 5. Results

The registries of 6 562 beneficiaries enrolled in the Insika Project between 2018-2022 complied with the inclusion criteria and were considered for the final analysis. **Figure 1** explains the flow chart of our sample selection process according to the inclusion and exclusion criteria.

Figure 1. Definition of sample size



## 5.1 General characteristics and prevalence of vaccine uptake of study population

Women predominated in our study population (78.3%), mostly explained by the highest number of beneficiaries enrolled in DREAMS program (38.4%). At end of FY22Q2, the median age was 18.2 years (interquartile range [ICR]: 15.8-22.1). Most of the vaccinated beneficiaries were between 15-17 years old (32.9%), are mostly from the OVC program (35.6%), from Lubombo region (40.5%), and Bantwana IP (33.4%); of the HIV positive beneficiaries, 389 (86.1%) were women and of the active beneficiaries, 4 619 (79.6%) were women. Of the beneficiaries enrolled at school at the moment of interview, 780 (17.3%) were from DREAMS and 692 (15.2%) were more than 19 years old; from them, almost 60% belong to DREAMS program. The only AGYW widowed in our sample had less than 20 years and is located in Hhohho. Bantwana, the IP with most enrolled beneficiaries, has its implementing areas located in Lubombo, Manzini and Hhohho. Most of the beneficiaries vaccinated were more likely to be active in comparison to beneficiaries not vaccinated. Beneficiaries not vaccinated were more likely to have children in comparison to beneficiaries vaccinated; of those, 698 (99.9%) were women. Pregnant AGYW were more likely to be vaccinated; most of the vaccinated ones were between 18-19 years old (148 [43.8%]). **Table 1** compares the main baseline characteristics of the study sample according to the vaccination status.

Table 1. Baseline characteristics of the sample by vaccination status

Variable	Total	Vaccinated	Not Vaccinated	p-value
	N=6 562	3 354 (51.1%)	3 208 (48.9%)	
Age (current in years)	18.2 (15.8-22.1)	<b>17.8</b> (15.7-20.4)	18.9 (16.0-23.4)	<0.001 <sup>†</sup>
Age group				<0.001 <sup>‡</sup>
12-14	1 228 (18.7%)	650 (19.4%)	578 (18.0%)	
15-17	1 874 (28.6%)	<b>1 104 (32.9%)</b>	770 (24.0%)	
18-19	1 138 (17.3%)	656 (19.6%)	482 (15.0%)	
20-24	1 357 (20.7%)	559 (16.7%)	798 (24.9%)	
25-29	965 (14.7%)	385 (11.5%)	580 (18.1%)	
Sex	N=6 558			<0.001 <sup>‡</sup>
Female	5 132 (78.3%)	<b>2 566 (76.5%)</b>	2 566 (80.0%)	
Male	1 426 (21.7%)	787 (23.5%)	639 (19.9%)	
Type of program	N=6 319			<0.001 <sup>‡</sup>
OVC	2 045 (32.3%)	<b>1 195 (35.6%)</b>	850 (26.5%)	
DREAMS	2 428 (38.4%)	915 (27.3%)	1 513 (47.2%)	
OVC DREAMS	1 846 (29.2%)	1 099 (32.8%)	747 (23.3%)	
Region	N=6 522			<0.001 <sup>‡</sup>
Hhohho	1 174 (18%)	536 (16.1%)	638 (20.0%)	
Manzini	2 258 (34.6%)	1 177 (35.3%)	1 081 (33.9%)	
Lubombo	2 618 (40.1%)	<b>1 350 (40.5%)</b>	1 268 (39.8%)	

Shiselweni	472 (7.2%)	270 (8.1%)	202 (6.3%)	
IP				<0.001 <sup>‡</sup>
AMICAALL	548 (8.4%)	152 (4.5%)	396 (12.3%)	
Bantwana	1 705 (25.9%)	<b>1 121 (33.4%)</b>	584 (18.2%)	
Cabrini	1 620 (24.7%)	773 (23.1%)	847 (26.4%)	
Compassionate	842 (12.8%)	442 (13.2%)	400 (12.5%)	
Lusweti	501 (7.6%)	199 (5.9%)	302 (9.4%)	
NCM	841 (12.8%)	382 (11.4%)	459 (14.3%)	
VOOV	108 (1.7%)	63 (1.9%)	45 (1.4%)	
World Vision	208 (3.2%)	119 (3.6%)	89 (2.8%)	
Young Heroes	186 (2.8%)	100 (3.0%)	86 (2.7%)	
Household socioeconomic status	N=1 950			0.006 <sup>‡</sup>
Employed	101 (5.2%)	52 (5.0%)	49 (5.4%)	
Self-employed	144 (7.4%)	59 (5.7%)	85 (9.3%)	
Unemployed with income	501 (25.7%)	257 (24.8%)	244 (26.8%)	
Unemployed with no income	1 204 (61.7%)	670 (64.6%)	534 (58.6%)	
AGYW Marital status	N=3 466			<0.001 <sup>‡</sup>
Single	3 094 (89.3%)	1 466 (92.1%)	1 628 (86.8%)	
Cohabiting	178 (5.1%)	55 (3.5%)	123 (6.6%)	
Married	182 (5.3%)	65 (4.1%)	117 (6.2%)	
Separated	7 (0.2%)	5 (0.3%)	2 (0.1%)	
Divorced	4 (0.1%)	0 (0.0%)	4 (0.2%)	
Widowed	1 (0.3%)	0 (0.0%)	1 (0.1%)	
National ID	1 584 (24.1%)	617 (18.4%)	967 (30.1%)	<0.001 <sup>‡</sup>
Enrolled at school	4 556 (69.4%)	2 505 (55.0%)	2 051 (45.0%)	<0.001 <sup>‡</sup>
HIV status	N=4069			0.005 <sup>‡</sup>
Positive	452 (11.1%)	277 (61.3%)	175 (38.7%)	
Negative	3 617 (88.9%)	1 962 (54.2%)	1 655 (45.8%)	
Active beneficiaries	5 802 (88.4%)	2 931 (50.5%)	2 871 (49.5%)	0.008 <sup>‡</sup>
AGYW Pregnant	N=5 132			<0.001 <sup>‡</sup>
Have children	446 (8.7%)	338 (75.8%)	108 (24.2%)	
	1 242 (18.9%)	543 (43.7%)	699 (56.3%)	<0.001 <sup>‡</sup>

<sup>‡</sup>T-test

<sup>‡</sup>Chi-square

Figures 2 and 3 show histograms of the overall age distribution of the sample population and age by sex, respectively, evidencing it is skewed to the left.



Figure 2. Age distribution among the sample population

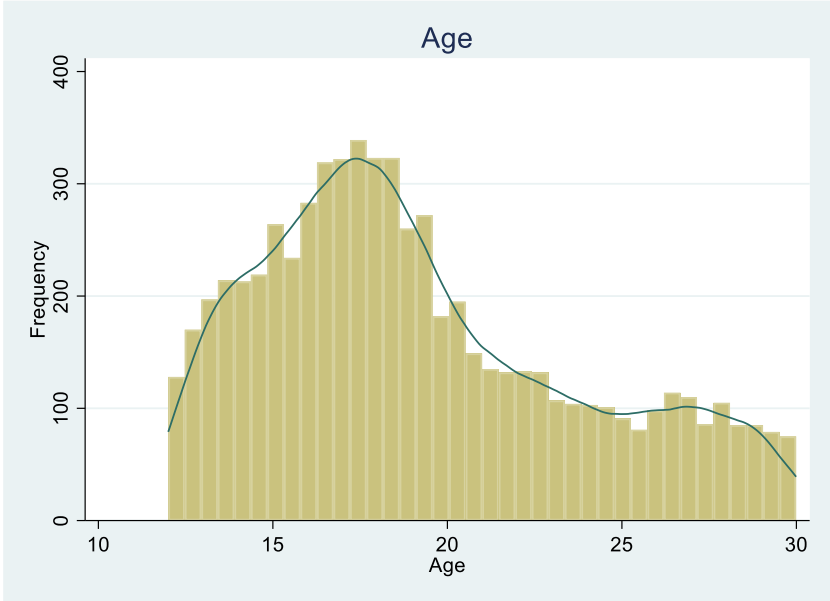
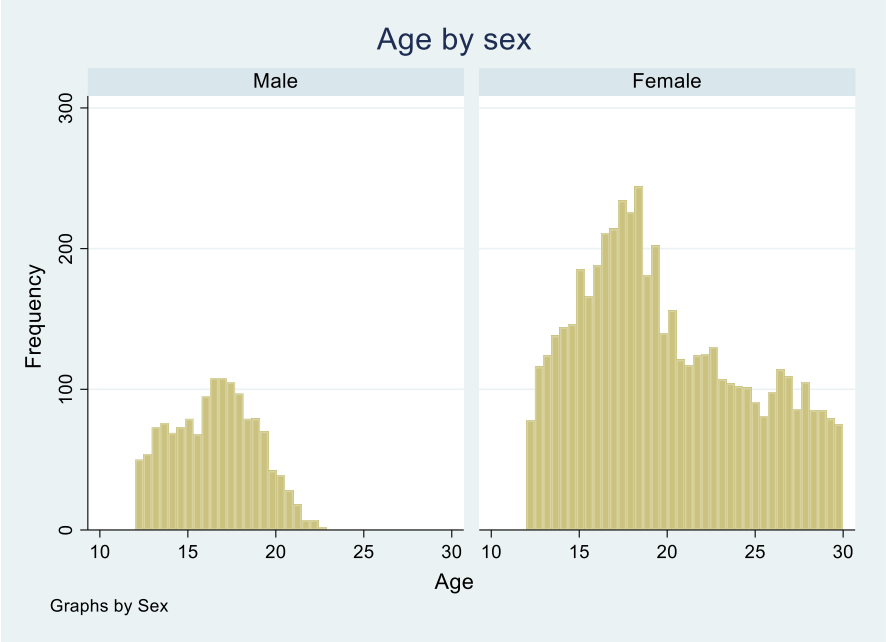


Figure 3. Age distribution by sex among the sample population



Of the beneficiaries who have their caregivers vaccinated (44.9%), 1 549 (48.3%) were not vaccinated. When adjusted for beneficiaries without siblings in the program to avoid duplicates of caregivers, the vaccinated caregivers were more likely to have beneficiaries not vaccinated (67.4%) in comparison to beneficiaries vaccinated (58.2%). When compared by program, the vaccinated caregivers were also more likely to have beneficiaries not vaccinated per program, either for DREAMS, OVC or OVC DREAMS. Figures 4, 5, 6 and 7 show the rates comparison of the vaccination status of the beneficiaries by their caregivers' vaccination. All of the bivariate associations were statistically significant with a p-value of <0.001. Since the beginning of the COVID-19 pandemic, 45 (0.7%) caregivers of the beneficiaries passed away.

Figure 4. Bar graph of beneficiary vaccination status by caregiver vaccinated for COVID-19: the column of beneficiaries with the caregiver vaccinated shows a higher frequency of beneficiaries without vaccine.

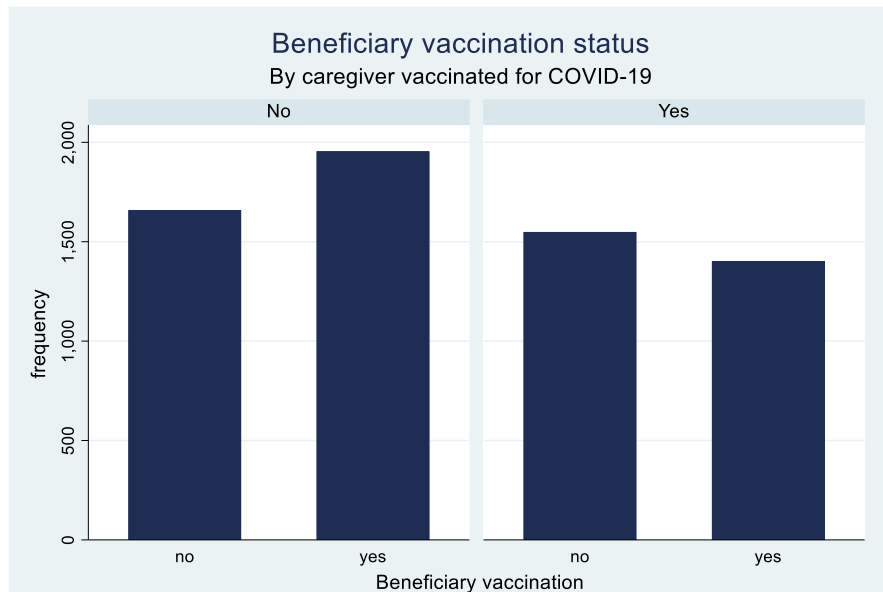


Figure 5. Bar graph of OVC vaccination status by caregiver vaccinated for COVID-19: the column of OVCs with the caregiver vaccinated shows a higher frequency of beneficiaries with the vaccine.

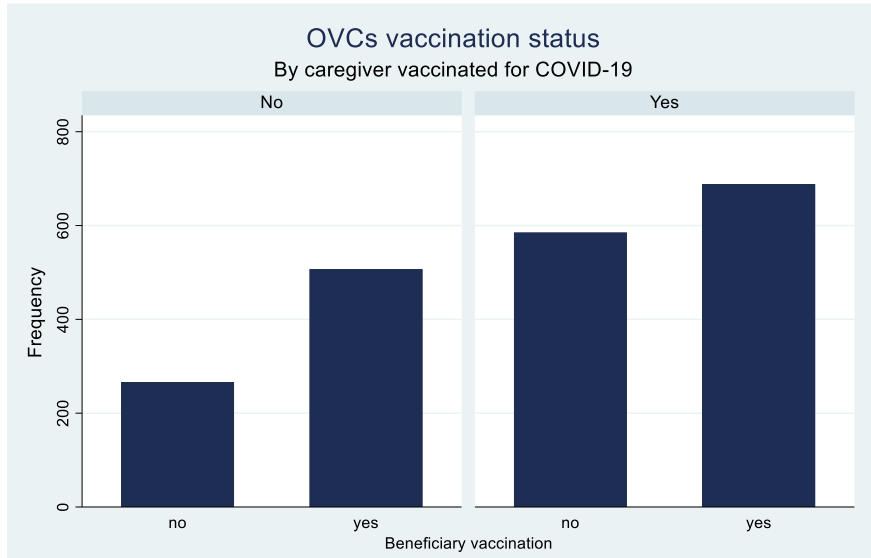
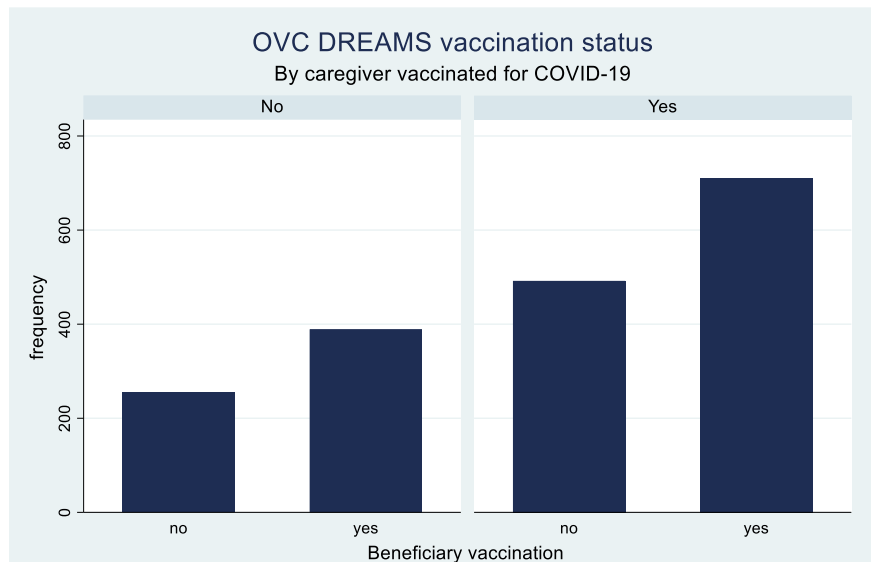


Figure 6. Bar graph of OVC DREAMS vaccination status by caregiver vaccinated for COVID-19: the column of OVC DREAMS with the caregiver vaccinated shows a higher number of children without vaccination in comparison to the column of the ones with a caregiver not vaccinated.



383 (84.7%) of the HIV positive beneficiaries were virally suppressed and 415 (91.8%) had active ART; 2 796 (64.5%) of beneficiaries' caregivers with HIV status were positive; and 210 (3.2%) beneficiaries were GBV cases, from which 44.8% were sexual abuse. In 4 274 beneficiaries from DREAMS or OVC DREAMS, 3 360 (78.6%) were in Life Mentorship and 2 625 (61.4%) in Youth Livelihoods. In 3 891 beneficiaries of OVC or OVC DREAMS, 1 697 (43.6%) received education services, 468 (12.0%) received health services, 1 264 (32.5%) received protection services, and 366 (9.4%) have been referred to clinical services. 797 (20.5%) of the caregivers with beneficiaries of OVC or OVC DREAMS were members of WORTH.

## 5.2 Predictors of vaccine uptake of study population

In the multivariate analysis for the outcome of beneficiary vaccinated at the moment of interview, the variables identified as vaccine uptake predictors were: region: Manzini (aOR 5.92; [95% CI] 1.70 - 20.60); pregnancies (aOR 5.81; [95% CI] 2.62 - 12.85); IP: Bantwana (aOR 6.04 [95% CI] 1.55 - 23.59), Cabrini (aOR 4.76; [95% CI] 1.05 - 21.65), and Young Heroes (aOR 21.49; [95% CI] 1.67 – 275.92); caregiver vaccinated for COVID-19 (aOR 0.52; [95% CI] 0.33 – 0.80); household economic status during COVID-19: self-employed (aOR 0.23; [95% CI] 0.11 – 0.49); protection services (aOR 0.61; [95% CI] 0.40 – 0.92); and life mentorship beneficiaries (aOR 0.57; [95% CI] 0.33 – 0.98). **Table 2** shows the variables retained in the final model.

Table 2. Predictors for COVID-19 vaccination outcome in the sample population

Factor	aOR	CI (95%)	P-value
<b>Region:</b>			
- Manzini	5.92	1.70 – 20.60	0.005
- Lubombo	1.35	0.42 – 4.37	0.616
- Shiselweni	5.02	0.90 – 28.10	0.067
AGYW pregnancies	5.81	2.62 – 12.85	<0.001
<b>IP:</b>			
- Bantwana	6.04	1.55 – 23.59	0.010
- Cabrini	4.76	1.05 – 21.65	0.043
- Compassionate	1.49	0.30 – 7.45	0.627
- Lusweti	0.39	0.07 – 2.01	0.258
- NCM	0.65	0.13 – 3.25	0.597
- Worldvision	2.46	0.19 – 32.16	0.493
- Young Heroes	21.49	1.67 – 275.92	0.019
Caregiver vaccinated for COVID-19	0.52	0.33 – 0.80	0.003

Household economic status during COVID-19:			
- Self-employed	0.23	0.11 – 0.49	<0.001
- Unemployed with income	0.54	0.27 – 1.09	0.192
- Unemployed with no income	0.50	0.18 – 1.45	0.205
GBV cases	2.23	0.75 – 6.61	0.148
Protection services	0.61	0.40 – 0.92	0.020
Health services	0.85	0.48 – 1.52	0.578
Life Mentorship beneficiaries	0.57	0.33 – 0.98	0.040

### 5.3 Predictors of vaccine uptake by beneficiary type

We segregate the models by type of program to make comparison of the predictors per group of beneficiaries. The applicable variables identified as vaccine uptake predictors for OVC were: sex (aOR 1.60; [95% CI] 1.02 – 2.52); school enrollment (aOR 0.22; [95% CI] 0.05 – 0.97); IP: Bantwana (aOR 15.75 [95% CI] 3.39 – 73.21); household economic status during COVID-19: self-employed (aOR 0.36; [95% CI] 0.17 – 0.76), unemployed with income (aOR 0.43; [95% CI] 0.21 – 0.84), unemployed with no income (aOR 0.28; [95% CI] 0.08 – 0.75; and health services (aOR 0.31; [95% CI] 0.15 – 0.64). **Table 3** shows the variables retained in the final model.

Table 3. Predictors for COVID-19 vaccination outcome in OVC sample population

Factor	aOR	CI (95%)	P-value
Sex	1.60	1.02 – 2.52	0.041
School enrollment	0.22	0.05 – 0.97	0.045
Region:			
- Manzini	1.24	0.29 – 5.36	0.777
- Lubombo	0.80	0.18 – 3.56	0.773
- Shiselweni	1.42	0.22 – 9.11	0.710

IP:			
- Bantwana	15.75	3.39 – 73.21	<0.001
- Cabrini	2.88	0.51 – 16.17	0.231
- Compassionate	4.44	0.79 – 24.95	0.091
- Lusweti	2.00	0.34 – 11.85	0.445
- NCM	2.59	0.45 – 14.94	0.289
- VOOV	1.70	0.17 – 17.60	0.655
- Worldvision	5.99	0.48 – 74.43	0.164
- Young Heroes	3.04	0.43 – 21.41	0.264
Active beneficiaries	1.55	0.46 – 5.23	0.479
Caregiver vaccinated for COVID-19	0.75	0.48 – 1.15	0.220
Household economic status COVID-19:			
- Self-employed	0.36	0.17 – 0.76	0.008
- Unemployed with income	0.43	0.21 – 0.84	0.015
- Unemployed with no income	0.28	0.08 – 0.75	0.014
GBV cases	0.96	0.36 – 2.54	0.936
Protection services	0.73	0.47 – 1.12	0.144
Health services	0.31	0.15 – 0.64	0.001

The applicable variables identified as vaccine uptake predictors for OVC DREAMS were: region: Manzini (aOR 5.92; [95% CI] 1.70 – 20.60; AGYW pregnancies (aOR 5.81; [95% CI] 2.62 – 12.85); IP: Bantwana (aOR 6.04 [95% CI] 1.55 – 23.59), Cabrini (aOR 4.76; [95% CI] 1.05 – 21.65), and Young Heroes (aOR 21.49; [95% CI] 1.67 – 275.92); caregiver vaccinated for COVID-19 (aOR 0.52; [95% CI] 0.33 – 0.80); household economic status during COVID-19: self-employed (aOR 0.23; [95% CI] 0.11 – 0.49); protection services (aOR 0.61; [95% CI] 0.40 – 0.92); and life mentorship beneficiaries (aOR 0.57; [95% CI] 0.33 – 0.98). **Table 4** shows the variables retained in the final model.

Table 4. Predictors for COVID-19 vaccination outcome in OVC DREAMS sample population

Factor	aOR	CI (95%)	P-value
Region:			
- Manzini	5.92	1.70 – 20.60	0.005
- Lubombo	1.35	0.42 – 4.37	0.616
- Shiselweni	5.02	0.90 – 28.11	0.067
AGYW pregnancies	5.81	2.62 – 12.85	<0.001
IP:			
- Bantwana	6.04	1.55 – 23.59	0.010
- Cabrini	4.76	1.05 – 21.65	0.043
- Compassionate	1.49	0.30 – 7.45	0.627
- Lusweti	0.39	0.07 – 2.01	0.258
- NCM	0.65	0.13 – 3.25	0.597
- Worldvision	2.46	0.19 – 32.16	0.493
- Young Heroes	21.49	1.67 – 275.92	0.019
Caregiver vaccinated for COVID-19	0.52	0.33 – 0.80	0.003
Household economic status COVID-19:			
- Self-employed	0.23	0.11 – 0.49	<0.001
- Unemployed with income	0.54	0.27 – 1.09	0.086
- Unemployed with no income	0.50	0.18 – 1.45	0.205
GBV cases	2.23	0.75 – 6.61	0.148
Protection services	0.61	0.40 – 0.92	0.020
Health services	0.85	0.48 – 1.52	0.578
Life Mentorship beneficiaries	0.57	0.33 – 0.98	0.040

The applicable variables identified as vaccine uptake predictors for DREAMS were: school enrollment (aOR 1.30; [95% CI] 1.08 – 1.56); IP: Bantwana (aOR 2.62 [95% CI] 1.78 – 3.86) and Young Heroes (aOR 2.24; [95% CI] 1.27 – 3.95); and life mentorship beneficiaries (aOR 0.62; [95% CI] 0.50 – 0.78). **Table 5** shows the variables retained in the final model.

Table 5. Predictors for COVID-19 vaccination outcome in DREAMS sample population

Factor	aOR	CI (95%)	P-value
School enrollment	1.30	1.08 – 1.56	0.005
Region:			
- Manzini	1.33	0.90 – 1.96	0.155
- Lubombo	0.93	0.65 – 1.33	0.689
- Shiselweni	1.19	0.56 – 2.50	0.650
AGYW pregnant	1.02	0.67 – 1.56	0.916
IP:			
- Bantwana	2.62	1.78 – 3.86	<0.001
- Cabrini	1.57	0.98 – 2.54	0.068
- Compassionate	1.36	0.81 – 2.27	0.246
- Lusweti	1.02	0.58 – 1.80	0.944
- NCM	0.75	0.44 – 1.27	0.285
- Worldwision	1.73	0.72 – 4.19	0.222
- Young Heroes	2.24	1.27 – 3.95	0.005
Active beneficiaries	0.91	0.66 – 1.26	0.558
GBV cases	0.85	0.20 – 3.70	0.831
Life Mentorship beneficiaries	0.62	0.50 – 0.78	<0.001



## 6. Discussion

In the present study, history of pregnancy and Manzini region were positive predictors for COVID-19 vaccination among the beneficiaries from the Insika project. On the contrary, having a caregiver fully vaccinated for COVID-19 and a self-employed caregiver had a negative association with the vaccination of the beneficiary. These predictors were especially strong among the OVC DREAMS girls of the program and vary when differentiated by the type of beneficiary.

For the purpose of the research, we considered only the pregnancies registered since 2020. The positive association is consistent with a worldwide survey that included South Africa in which more than 50% of pregnant women were willing to receive COVID-19 vaccine if it has at least a known 90% efficacy (39). Although other studies showed a wide variability of pregnant women's willingness to vaccinate (40), our results are context specific for Eswatini. Despite the general mistrust in the country's health system, the association might be related to other co-factors that have been found to support this positive relationship between the general population and pregnant women such as confidence in mass vaccination campaigns and previous history of influenza vaccination (41,42), which is available in Eswatini only in the private sector. It should be considered that our sample population has received differentiated medical and social support from the Insika project and other partners that might bias their perceptions and trust in the health system in contrast to the general population. Eswatini government launched in March 2021 a COVID-19 vaccination campaign (43) that emphasized the pros and cons of the vaccine's side effects versus the importance of protecting those at higher risk of exposure, such as pregnant women. Furthermore, as the majority of the HIV positive pregnant women in our sample were vaccinated, the vaccination campaign might have had a special effect on these women considering their previous education and empowerment they have received as PLHIV.

Besides pregnancy, the other positive predictor of our model that is consistent with the previous literature is place of residence. In our model, living in Manzini was a positive predictor of COVID-19 vaccination for the overall sample population and OVC DREAMS. Manzini has a higher number of partners working in the region in comparison to other ones, including Bantwana, the IP with biggest areas within its jurisdiction. There may be a historical impact on the residents of Manzini, region with a high number of urban areas in comparison to the rest of the country (21), as it was the one most affected by COVID-19. Hhohho, another mostly urban region where the capital of the country is located, is not included in the model because it is the point of reference for the region variable.

Bantwana, Cabrini, and Young heroes IPs are also positive predictors of beneficiaries' vaccination. Bantwana works in the following Tinkhundla: Dvokodweni, Lobamba, Lobamba Lomdzala, Lomahasha, Madlangempisi, Mhlume, Mkhiweni, and Nkhaba; including two highly populated Inkhundla from Manzini (Lobamba and Mkhiweni). Cabrini works in Gilgal, Siphofaneni, and Sithobela; it is the only IP that met the FY22Q2 targets from the program. Young Heroes works in Mhlangatane, Motjane, Ntfontjeni, Pigg's Peak, and Siphocosini; most of them

from Hhohho, which provides useful information on the positive vaccination uptake status in that region.

The predictors related to caregivers were filtered for OVC and OVC DREAMS only as the beneficiaries under DREAMS do not have an engagement in the program with a caregiver, even though some of them have caregivers' registries in our sample because they might have siblings in the Insika project that were excluded from our study.

In our study, the proportion of beneficiaries vaccinated with vaccinated caregivers is higher in OVC DREAMS than in OVCs, though only the first group has caregiver vaccination as a negative predictor for our main outcome when adjusted for confounders. Both groups have a higher number of beneficiaries between 15 to 17 years old, but OVC has more beneficiaries within the 12 to 14 years old group and OVC DREAMS has more beneficiaries above 18 years old. A previous report showed that mothers are willing to vaccinate their children against COVID-19, especially those who routinely immunized their under-5-years-old children with other vaccines (39). Children's immunization rates for VPDs in Eswatini for 2021 are above 70% except for 2<sup>nd</sup> dose of measles and 3<sup>rd</sup> dose of polio (44), which are lower than the previous years as the ascending trend was impacted by the COVID-19 policy restrictions. This age difference in vaccination patterns might partially explain the negative association of caregiver vaccination predictor for OVC DREAMS and no association for OVCs as more emphasis is put on immunization health services for minor children in contrast to OVC DREAMS, who are older and mostly receive other types of services within the package. Further investigation needs to be done to better understand the discrepancies between these two groups.

The rate of complete COVID-19 vaccination among the general population of Eswatini between 12 to 29 years old until the end of June 2022 (421 400 citizens by 2022 (45)) is 15% according to local data from the MOH, in contrast to the 51.1% vaccination rate of our sample, evidencing the positive effect of the COVID-19 response within the Insika beneficiaries. The total 12 to 29 years old Swati population has an overall median age of 17 years old (ICR 14-23) and 57.9% are female, similar to the data from our sample.

There are myths about the COVID-19 pandemic and the development of its vaccine that might still affect vaccination uptake despite the massive campaign and community education led by the COVID-19 response. These are related to the vaccine side-effects, including infertility, low sex drive, and death; the experimental nature and rapid approval of the vaccine; and religious beliefs, such as receiving the mark of the devil if vaccinated (29). Approximately, 90% of the Swati population is Christian; 2% are Muslims, mostly non-ethnic Swati; and the rest practice African indigenous religions. Estimates report that 40% of the Christians practice Zionism; 20% are Roman Catholicism; and the rest, are Anglicans, Methodists, and from other churches (46). In addition, Christianity is mandatorily taught in all the public schools in Eswatini; teaching other religions is banned by law. Some verbal testimonies from community members assure that some Church Ministers have forbidden their fellows to vaccinate as they say it goes against their religion. Exploring the influence of religion on the vaccination status of the beneficiaries could help to better understand the negative association between caregiver and child vaccination, as the caregivers might get vaccinated because of employment or other personal needs but are not willing

to expose their children to the vaccine risks they believe to. A different approach should be taken to engage religious leaders in the COVID-19 response.

Another possible reason for low vaccination uptake in the youth is the low hospitalization rates in the country. During the third and fourth waves, admissions reports were of 1 in 25 COVID-19 cases and 1 in 100 COVID-19 cases, respectively, from which 80% were not vaccinated (47). Overall, COVID-19 mortality rates in the country have not exceeded 1500 deaths (4). Moreover, vaccines were introduced in Eswatini at different points in time since April 2021 for different ages and groups at risk. The sensation of safety and low fatality rates in the country when vaccines were available for them might prevent the youth to vaccinate.

Insika beneficiaries are always monitored and referred to health services as needed. These are facilities that children and AGYW attend routinely, and where the COVID-19 vaccine was widely administered. However, in this study, referral to health services was associated with less likelihood of vaccination among OVCs. The negative impact of this service on our main outcome could be explained by the different demand creation from the program: the users of these services are not necessarily the same ones targeted to vaccinate, as it targets specific outcomes not related to COVID-19. Additionally, there is a lack of interoperability with the health facilities that difficult for the client to provide another service besides the one that he or she was referred to.

The vaccination campaign attracted people from different areas and ages to the health facilities, making them unsafe and unconfident places for the beneficiaries. This same effect might have impacted the DREAMS users of Life Mentorship service, a negative predictor for vaccination among AGYW under DREAMS in our model. In the case of DOW, vaccination was administered in the mobile clinics for the whole community as part of the national campaign. As consequence, AGYW users from the program avoided attending the clinics because it was not a safe place as it used to be for them. In general, the beneficiaries' dispute to keep attending these services elucidates the negative effects of Life Mentorship and health services referral.

Receiving protection services to obtain a national ID also had a negative effect on vaccination for the overall population and specifically for OVC DREAMS. One common reason to obtain the vaccine in Eswatini has been the need of travelling to South Africa, a country that requires proof of complete vaccination within its borders. These beneficiaries are not able to travel because they do not have a passport and are currently in the process of obtaining birth certificates, which might explain the negative prediction. According to the most recent data, only 54% of the Swati population have completeness of birth registration and among the females, only 50% completed it (48). Among the Insika beneficiaries between 0 to 17 years old, 1.8% have obtained a birth certificate since the beginning of the program.

Our models also predicted caregivers' self-employment as a negative effect. It includes caregivers running a small business or producing their own food from their farms. These parents may feel fully sufficient without the need to vaccinate or be too busy with their business which may impede them to have enough time to vaccinate themselves and their children. In addition, the government's vaccination campaign has been focused on the working population, excluding these specific population. New strategies should contemplate door-to-door vaccination for these hard-

to-reach populations that can not attend the vaccination mobile sites, even if they are installed within their communities, as it has proved efficacy in vaccination rates increase in other countries in the region (49). In the case of the OVCs, all these beneficiaries were less likely to be vaccinated if the caregiver was not formally employed during the COVID-19 pandemic in contrast to the formally employed, evidencing their vulnerability to external changes such as the economic status of their caregivers. This is supported by previous research that confirmed a relationship between worst socioeconomic status and a higher burden of COVID-19 in the pediatric population (50).

Our study shows discrepancies in the school enrollment predictor between OVC and DREAMS, being negative for the first one but positive for the second one. Before the entry of vaccines into the country, schools closed from March 2020 to March 2021 following the lockdown restrictions imposed by the government. However, after the social unrest and political movement in June 2021, school closures occurred intermittently throughout the year, in August, October, December 2021, and March 2022. As vaccines became available for children between 12 to 17 years old in October 2021, and the national strategy includes installing points of vaccination within the schools, there were missed opportunities for OVCs to get vaccinated during that period. On the contrary, DREAMS beneficiaries, as they are older, could get the advantage of vaccinating at their schools before the schools' closure in 2021; 52.2% of the DREAMS beneficiaries in our sample who were enrolled at school and have not dropped are over 18 years old.

Finally, HIV positive status was associated with COVID-19 vaccination in the bivariate analysis; however, when adjusted by confounders in the multivariate analysis, we found no association and was excluded from the final model. Recent studies showed PLHIV are at higher risk of severe COVID-19 and death regardless of their VL levels (10). According to UNAIDS, Eswatini has 7200 children under 15 years old living with HIV and the HIV prevalence rate among young women is 12.6 (31). In our sample, 11.1% have a positive HIV test but 38% of the population do not have a registered HIV test result. Despite no association identified in the model, we consider that positive HIV status should be a positive predictor of COVID-19 vaccination within the program. CALHIV should be considered as a targeting population given the higher risk they face in order to promptly obtain a 100% rate of complete COVID-19 vaccination.

## **7. Limitations of the study**

The present study has selection bias as one of its main limitations because it includes registries of a population from households who accepted to receive COVID-19 education and pre-registered in the forms to receive the vaccine. However, several demographic characteristics of our sample are similar to the ones from the population that did not receive vaccine offer through the COVID-19 response.

As this was a secondary data study, we did not have control of the point of time and quality of the data collection procedures; however, the Insika project team has well-trained community personnel from the IPs who routinely visit the beneficiaries at least once every three months to update the data. Additionally, we conducted an extensive review of the database to resolve inconsistencies and missing data.

Also due to the secondary data, we did not use valuable variables that were not available or not standardized in the database such as religion, place and types of vaccine administered, reasons for willingness to vaccinate, previous vaccination patterns including history of influenza vaccine, data of those vaccinated outside the country, and knowledge of vaccine efficacy. The birth certificate variable was inaccurate and might be underestimated as several registries had typos mistakes that impede them to be included in the positive outcome of having a national ID.

The analysis includes some duplicate information about caregivers because there are siblings with the same primary caregiver in our sample, but we restricted the bivariate analysis to caregivers with either one child or more than one in our sample, obtaining similar statistically significant patterns in each group.

The main strengths of this study are the large study sample data we analyzed from the Insika project that is implemented throughout the country and the most recent updated information we included in the analysis until the end of FY22Q2.

## **8. Conclusions and recommendations**

History of pregnancy since the beginning of the COVID-19 pandemic and urban places of residence can be positive predictors of COVID-19 vaccination in AGYW and OVCs in Eswatini. On the contrary, having caregivers vaccinated for COVID-19 and unstable household economic status can be negative predictors of vaccination among the same population in the country. Socioeconomic inequalities in Eswatini may directly affect the COVID-19 vaccine uptake in vulnerable citizens despite the resources allocated for the national campaign. Furthermore, despite the high COVID-19 knowledge in the Swati population, the personal beliefs of either pregnant women or parents of vulnerable children may still positively or negatively influence the willingness to vaccinate, respectively.

The Eswatini Vaccine National Campaign and COVID-19 response should focus its efforts and differentiate the campaign messaging on specific target populations such as vaccinated primary caregivers, unemployed caregivers, and younger and HIV-positive beneficiaries. Future research should evaluate the influence of religion – among other factors - on vaccination status in the beneficiaries' households and specific reasons for not vaccinating after receiving vaccine education and offer.

The response implementation should consider a change of the vaccination strategy from community vaccination mobile sites to door-to-door vaccination for hard-to-reach populations and an interoperability program with the health facilities to provide an integral service while keeping them safe places for OVCs and AGYW.

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# Appendices

## A1. Development of multivariate analysis models adjusted for confounders.

1. First model: we included statistically significant variables from the bivariate analysis that has been identified as predictors for COVID-19 vaccination in the literature.

```
. logit BeneficiaryVaccinated_ Age i.AgeGroup12 i.AGYW_Marital_status_Clean_n i.Household_Economic_Status_Clean i.region B
> eneficiary_HIV_Status AGYW_pregnant have_child, or

note: 5.AgeGroup12 != 0 predicts success perfectly;
      5.AgeGroup12 omitted and 1 obs not used.

note: 3.AGYW_Marital_status_Clean_n != 0 predicts failure perfectly;
      3.AGYW_Marital_status_Clean_n omitted and 1 obs not used.

note: 4.AGYW_Marital_status_Clean_n != 0 predicts success perfectly;
      4.AGYW_Marital_status_Clean_n omitted and 1 obs not used.

note: 6.AGYW_Marital_status_Clean_n != 0 predicts failure perfectly;
      6.AGYW_Marital_status_Clean_n omitted and 1 obs not used.

Iteration 0:  log likelihood = -472.69516
Iteration 1:  log likelihood = -432.25204
Iteration 2:  log likelihood = -431.73958
Iteration 3:  log likelihood = -431.73813
Iteration 4:  log likelihood = -431.73813

Logistic regression                               Number of obs =   692
                                                    LR chi2(14)  =  81.91
                                                    Prob > chi2  =  0.0000
                                                    Pseudo R2   =  0.0866

Log likelihood = -431.73813
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
Age	.8852494	.0955698	-1.13	0.259	.7164264	1.093855
AgeGroup12						
15-17yrs	1.095744	.3983452	0.25	0.801	.5373586	2.234363
18-19yrs	1.317936	.7889853	0.46	0.645	.4076809	4.260573
20-24yrs	3.711257	3.094462	1.57	0.116	.7240782	19.02201
25-29yrs	1 (empty)					
AGYW_Marital_status_Clean_n						
married	1 (empty)					
separated	1 (empty)					
single	.8061511	.9959133	-0.17	0.862	.0715893	9.077886
widowed	1 (empty)					
Household_Economic_Status_Clean						
Self-employed	.8448459	.3830039	-0.37	0.710	.34745	2.054294
Unemployed with income	.8339396	.3314931	-0.46	0.648	.3826307	1.817563
Unemployed with no income	1.174238	.4414874	0.43	0.669	.5619828	2.453516
region						
Manzini	3.351611	1.039867	3.90	0.000	1.824571	6.156679
Lubombo	3.467888	1.063332	4.06	0.000	1.901374	6.32503
Shiselweni	6.443985	3.334106	3.60	0.000	2.337461	17.76498
Beneficiary_HIV_Status	1.346839	.4696578	0.85	0.393	.679974	2.667714
AGYW_pregnant	4.630145	1.519342	4.67	0.000	2.433774	8.808643
have_child	1.745953	.5472598	1.78	0.075	.944556	3.227284
_cons	2.508357	4.889287	0.47	0.637	.054983	114.4328

Note: \_cons estimates baseline odds.

- Second model: we included the statistically significant variables from the first model plus the statistically significant project-specific variables from the bivariate analysis, segregated by each type of program.

## 2.1 Model for overall population

```
. logit BeneficiaryVaccinated_ i.region AGYW_pregnant HasNatID i.IP_n i.DREAMS_OVC_n active newcases, or
```

```
Iteration 0: log likelihood = -3423.2837
Iteration 1: log likelihood = -3108.2122
Iteration 2: log likelihood = -3107.7075
Iteration 3: log likelihood = -3107.7074
```

```
Logistic regression                Number of obs = 4,939
                                   LR chi2(17) = 631.15
                                   Prob > chi2 = 0.0000
                                   Pseudo R2 = 0.0922
Log likelihood = -3107.7074
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
region						
Manzini	1.48254	.2173012	2.69	0.007	1.112353	1.975923
Lubombo	.9118825	.1248915	-0.67	0.501	.6972015	1.192668
Shiselweni	1.667151	.4163722	2.05	0.041	1.021849	2.719964
AGYW_pregnant	2.779411	.3401302	8.35	0.000	2.186689	3.532795
HasNatID	.8537569	.0695697	-1.94	0.052	.7277342	1.001603
IP_n						
Bantwana	4.341843	.6803986	9.37	0.000	3.19363	5.902875
Cabrini	2.392469	.4493844	4.64	0.000	1.655628	3.457244
Compassionate	1.865686	.3680658	3.16	0.002	1.267395	2.746408
Lusweti	1.111041	.2381132	0.49	0.623	.7299692	1.691047
NCM	1.300957	.2630647	1.30	0.193	.8752709	1.933674
VOOV	1.13689	.4423834	0.33	0.742	.5302751	2.437449
Worldvision	2.000669	.6367178	2.18	0.029	1.072206	3.733122
Young Heroes	2.740867	.6217567	4.44	0.000	1.757097	4.275434
DREAMS_OVC_n						
OVC	2.701457	.2825535	9.50	0.000	2.200738	3.316101
OVC DREAMS	2.042753	.1620365	9.00	0.000	1.748624	2.386357
active	.7209959	.0869995	-2.71	0.007	.5691438	.9133634
newcases	1.495978	.291067	2.07	0.038	1.021668	2.190485
_cons	.3365498	.0553201	-6.63	0.000	.2438562	.4644776

Note: **\_cons** estimates baseline odds.

## 2.2 Model for OVC population: the pregnancy variable was excluded from this model because only 3.6% of the OVC population had been pregnant and, if included, it delivered a non-statistically model as it limited the observations for only females' registries.

```
. logit BeneficiaryVaccinated_ i.region HasNatID i.IP_n i.DREAMS_OVC_n active Caregiver_Vaccinated_for_COVID i.Caregiver_Economic_Status_Clean Caregiver_HI
> V_STATUS newcases education_Service health_Service protection_service referred_clinical_Services Caregiver_WORTH_Member_n if OVC=1, or
```

```
note: 2.DREAMS_OVC_n omitted because of collinearity.
Iteration 0: log likelihood = -328.72227
Iteration 1: log likelihood = -286.89409
Iteration 2: log likelihood = -286.4674
Iteration 3: log likelihood = -286.46604
Iteration 4: log likelihood = -286.46604
```

```
Logistic regression                               Number of obs = 481
LR chi2(24) = 84.51
Prob > chi2 = 0.0000
Pseudo R2 = 0.1285
Log likelihood = -286.46604
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]
region					
Manzini	1.433645	1.073345	0.48	0.630	.3304928 6.21901
Lubombo	.9876965	.7586183	-0.02	0.987	.2192011 4.450454
Shiselweni	1.509257	1.438356	0.43	0.666	.2331034 9.771869
HasNatID	.6186836	.3034234	-0.98	0.328	.2365977 1.617807
IP_n					
Bantwana	12.35104	9.611091	3.23	0.001	2.687397 56.76426
Cabrin	2.15093	1.904048	0.87	0.387	.3794244 12.19348
Compassionate	3.300425	2.915728	1.35	0.177	.5842306 18.6447
Lusweti	1.504525	1.371952	0.45	0.654	.2518851 8.986616
NCM	1.823751	1.632301	0.67	0.502	.3155876 10.53929
VOOV	1.653788	1.972499	0.42	0.673	.1596756 17.12858
Worldvision	4.769817	6.172768	1.21	0.227	.377516 60.26541
Young Heroes	3.052463	3.389706	1.00	0.315	.346263 26.90882
DREAMS_OVC_n					
OVC	1 (omitted)				
active	1.194727	.7554193	0.28	0.778	.3459861 4.12552
Caregiver_Vaccinated_for_COVID	.7108984	.1671944	-1.45	0.147	.4483484 1.127196
Caregiver_Economic_Status_Clean					
Self-employed	.3974075	.1553805	-2.36	0.018	.1846837 .8551522
Unemployed with income	.4777094	.1691295	-2.09	0.037	.2386724 .9561488
Unemployed with no income	.4131306	.242601	-1.51	0.132	.1306892 1.305976
Caregiver_HIV_STATUS					
newcases	.9104923	.2369432	-0.36	0.719	.5467171 1.516317
education_Service	.9646743	.4780669	-0.07	0.942	.3652144 2.548083
health_Service	.8203892	.3076343	-0.53	0.598	.3933973 1.710836
protection_service	.3909565	.1592468	-2.31	0.021	.1759592 .8686504
referred_clinical_Services	.8104601	.299682	-0.57	0.570	.3926311 1.672933
Caregiver_WORTH_Member_n	1.301947	.7870584	0.44	0.662	.3981269 4.257603
_cons	.553732	.1366189	-2.40	0.017	.3414192 .8980723
_cons	1.41398	1.094285	0.45	0.654	.3102381 6.444533

Note: \_cons estimates baseline odds.

## 2.3 Model for OVC DREAMS population

```
. logit BeneficiaryVaccinated_ i.region AGYW_pregnant HasNatID i.IP_n i.DREAMS_OVC_n active Caregiver_Vaccinated_for_COVID i.Caregiver_Economic_Status_Clean Caregiver_HIV_STATUS newcases education_Service health_Service protection_service referred_clinical_Services Caregiver_WORTH_Member_n LifeMentorship if OVC DREAMS==1, or
```

note: **active** != 1 predicts failure perfectly;  
**active** omitted and 1 obs not used.

note: **3.DREAMS\_OVC\_n** omitted because of collinearity.

```
Iteration 0: log likelihood = -344.60106
Iteration 1: log likelihood = -277.91961
Iteration 2: log likelihood = -276.40698
Iteration 3: log likelihood = -276.39872
Iteration 4: log likelihood = -276.39872
```

```
Logistic regression                               Number of obs = 507
LR chi2(24) = 136.40
Prob > chi2 = 0.0000
Pseudo R2 = 0.1979
Log likelihood = -276.39872
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
region						
Manzini	6.277121	4.046622	2.85	0.004	1.774284	22.20741
Lubombo	1.486997	.9068792	0.65	0.515	.4499718	4.913997
Shiselweni	4.693443	4.151106	1.75	0.080	.8291787	26.56654
AGYW_pregnant	5.994926	2.512887	4.27	0.000	2.63625	13.63267
HasNatID	.4451055	.2441062	-1.48	0.140	.1519303	1.304012
IP_n						
Bantwana	5.63889	3.994491	2.44	0.015	1.406751	22.6032
Cabrini	4.886882	3.859946	2.01	0.045	1.039209	22.98057
Compassionate	1.607544	1.349405	0.57	0.572	.3102039	8.330644
Lusweti	.3342772	.2868909	-1.28	0.202	.0621684	1.797397
NCM	.5501478	.4639272	-0.71	0.479	.1053611	2.872622
Worldvision	2.721657	3.63409	0.75	0.453	.1987317	37.27346
Young Heroes	20.36241	26.47042	2.32	0.020	1.593296	260.2326
DREAMS_OVC_n						
OVC DREAMS	1	(omitted)				
active	1	(omitted)				
Caregiver_Vaccinated_for_COVID	.5077389	.1173647	-2.93	0.003	.3227631	.7987247
Caregiver_Economic_Status_Clean						
Self-employed	.2219674	.0859773	-3.89	0.000	.1038922	.4742371
Unemployed with income	.5564828	.2036079	-1.60	0.109	.2716509	1.139967
Unemployed with no income	.6334005	.3505409	-0.83	0.409	.2140921	1.873943
Caregiver_HIV_STATUS	.8181672	.2129869	-0.77	0.441	.4911968	1.362789
newcases	2.472235	1.390964	1.61	0.108	.8206815	7.447406
education_Service	1.82668	.6015983	1.83	0.067	.9579176	3.483349
health_Service	.6882671	.2226106	-1.16	0.248	.3651299	1.297378
protection_service	.4097732	.129981	-2.81	0.005	.2200596	.7630389
referred_clinical_Services	1.033456	.3015491	0.11	0.910	.5833412	1.830888
Caregiver_WORTH_Member_n	.6532311	.1640607	-1.70	0.090	.3992871	1.068682
LifeMentorship	.557671	.1542933	-2.11	0.035	.3242443	.9591438
_cons	1.400073	.8309978	0.57	0.571	.437451	4.480969

Note: **\_cons** estimates baseline odds.

## 2.4 Model for DREAMS population

```
. logit BeneficiaryVaccinated_ i.region AGYM_pregnant HasNatID i.IP_n i.DREAMS_OVC_n active newcases LifeMentorship if Dreams==1, or

note: 1.DREAMS_OVC_n omitted because of collinearity.
Iteration 0: log likelihood = -1593.1517
Iteration 1: log likelihood = -1542.6185
Iteration 2: log likelihood = -1542.4396
Iteration 3: log likelihood = -1542.4396

Logistic regression                               Number of obs = 2,405
LR chi2(15) = 101.42
Prob > chi2 = 0.0000
Pseudo R2 = 0.0318

Log likelihood = -1542.4396
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]
region					
Manzini	1.372167	.2712985	1.60	0.110	.9313464 2.021634
Lubombo	.9586709	.1744451	-0.23	0.817	.671089 1.36949
Shiselweni	1.260109	.4766997	0.61	0.541	.6003417 2.644953
AGYM_pregnant	1.042605	.2231093	0.19	0.845	.6854402 1.58588
HasNatID	.9007111	.0787184	-1.20	0.231	.7589166 1.068998
IP_n					
Bantwana	2.589263	.5103496	4.83	0.000	1.759553 3.810219
Cabrini	1.591122	.3913609	1.89	0.059	.9825111 2.576734
Compassionate	1.353076	.3546004	1.15	0.249	.8095575 2.261499
Lusweti	.9660423	.2787051	-0.12	0.905	.548811 1.700472
NCM	.7356009	.1983214	-1.14	0.255	.433665 1.247757
Worldvision	1.686243	.7581265	1.16	0.245	.6985928 4.070204
Young Heroes	2.281336	.6584154	2.86	0.004	1.295759 4.016559
DREAMS_OVC_n					
DREAMS	1	(omitted)			
active	.9135094	.1510653	-0.55	0.584	.6606196 1.263207
newcases	.8150166	.6092476	-0.27	0.784	.1883084 3.527469
LifeMentorship	.6399028	.074724	-3.82	0.000	.5089977 .8044744
_cons	.5889692	.1160419	-2.69	0.007	.4002987 .8665647

Note: **\_cons** estimates baseline odds.



- Third model: we included the statistically significant variables from the previous second models that apply for the three programs plus the variables sex and school enrollment that were omitted in the first model due to collinearity and perfect failure prediction, respectively.

```

. logit BeneficiaryVaccinated_ Sex enrolled_School i.region AGYW_pregnant i.IP_n i.DREAMS_OVC_n active newcases Caregiver_Vaccinated_for_COVID i.Caregiver_Econo
> mic_Status_Clean health_Service protection_service LifeMentorship, or

note: enrolled_School != 1 predicts success perfectly;
      enrolled_School omitted and 1 obs not used.

note: active != 1 predicts failure perfectly;
      active omitted and 1 obs not used.

note: Sex omitted because of collinearity.
note: 3.DREAMS_OVC_n omitted because of collinearity.
Iteration 0: log likelihood = -347.20456
Iteration 1: log likelihood = -283.7287
Iteration 2: log likelihood = -282.24571
Iteration 3: log likelihood = -282.23869
Iteration 4: log likelihood = -282.23869

Logistic regression                               Number of obs = 510
                                                    LR chi2(19) = 129.93
                                                    Prob > chi2 = 0.0000
Log likelihood = -282.23869                       Pseudo R2 = 0.1871

```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
Sex	1 (omitted)					
enrolled_School	1 (omitted)					
region						
Manzini	5.914993	3.765018	2.79	0.005	1.698816	20.59501
Lubombo	1.351056	.8096443	0.50	0.616	.4174226	4.372914
Shiselweni	5.018274	4.411322	1.84	0.067	.8959924	28.10635
AGYW_pregnant	5.805244	2.353107	4.34	0.000	2.622969	12.84836
IP_n						
Bantwana	6.043602	4.199012	2.59	0.010	1.548434	23.58843
Cabrimi	4.763558	3.679713	2.02	0.043	1.0481	21.65012
Compassionate	1.490591	1.223868	0.49	0.627	.2981738	7.45157
Lusweti	.3848484	.324684	-1.13	0.258	.0736476	2.011039
NCM	.6477389	.5325642	-0.53	0.597	.1292858	3.245256
Worldvision	2.459233	3.225785	0.69	0.493	.1880508	32.16058
Young Heroes	21.48824	27.98554	2.36	0.019	1.673498	275.9157
DREAMS_OVC_n						
OVCOREAMS	1 (omitted)					
active	1 (omitted)					
newcases	2.22953	1.235824	1.45	0.148	.7523048	6.607432
Caregiver_Vaccinated_for_COVID	.5154166	.1161504	-2.94	0.003	.3313889	.8016388
Caregiver_Economic_Status_Clean						
Self-employed	.231926	.0893753	-3.79	0.000	.1089756	.4935936
Unemployed with income	.5380286	.1945088	-1.71	0.086	.2648975	1.09278
Unemployed with no income	.5038092	.2723214	-1.27	0.205	.1746508	1.453321
health_Service	.8480599	.2509443	-0.56	0.578	.4748458	1.514609
protection_service	.6089029	.129692	-2.33	0.020	.4010958	.9243743
LifeMentorship	.5701411	.1561056	-2.05	0.040	.3333665	.9750858
_cons	1.181905	.655697	0.30	0.763	.3984307	3.506

Note: \_cons estimates baseline odds.

### 3.1. Third model for OVC: we only included applicable variables for OVC observations.

```
. logit BeneficiaryVaccinated_ Sex enrolled_School i.region i.IP_n i.DREAMS_OVC_n active newcases Caregiver_Vaccinated_for_COVID i.Caregiver_Economic_Status_Clean health_Service protection_service if OVC==1, or
```

note: 2.DREAMS\_OVC\_n omitted because of collinearity.

```
Iteration 0: log likelihood = -333.7323
Iteration 1: log likelihood = -289.98392
Iteration 2: log likelihood = -289.244
Iteration 3: log likelihood = -289.24255
Iteration 4: log likelihood = -289.24255
```

```
Logistic regression                               Number of obs = 487
LR chi2(21) = 88.98
Prob > chi2 = 0.0000
Pseudo R2 = 0.1333
Log likelihood = -289.24255
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
Sex	1.60137	.3696943	2.04	0.041	1.01855	2.517684
enrolled_School	.222513	.1669534	-2.00	0.045	.0511318	.9683208
region						
Manzini	1.235983	.9246173	0.28	0.777	.285262	5.355271
Lubombo	.802654	.6104319	-0.29	0.773	.1807903	3.563539
Shiselweni	1.421827	1.347587	0.37	0.710	.2218656	9.111781
IP_n						
Bantwana	15.74647	12.34635	3.52	0.000	3.386734	73.21252
Cabrini	2.875651	2.53404	1.20	0.231	.5112727	16.17409
Compassionate	4.436572	3.908766	1.69	0.091	.7890616	24.94504
Lusweti	2.000527	1.815616	0.76	0.445	.3377693	11.84864
NCM	2.584764	2.313281	1.06	0.289	.4473248	14.93547
VOOV	1.703157	2.029451	0.45	0.655	.1648078	17.60076
Worldvision	5.985185	7.696962	1.39	0.164	.4813161	74.42602
Young Heroes	3.039814	3.027819	1.12	0.264	.4315232	21.41361
DREAMS_OVC_n						
OVC	1	(omitted)				
active	1.551067	.9621752	0.71	0.479	.4598365	5.231876
newcases	.9609575	.4770327	-0.08	0.936	.3632084	2.54245
Caregiver_Vaccinated_for_COVID	.7534944	.1738876	-1.23	0.220	.4793405	1.184448
Caregiver_Economic_Status_Clean						
Self-employed	.3575605	.1381661	-2.66	0.008	.1676618	.7625441
Unemployed with income	.4190966	.1491517	-2.44	0.015	.2086322	.8418738
Unemployed with no income	.2442689	.1394703	-2.47	0.014	.0797733	.7479613
health_Service	.3121272	.113099	-3.21	0.001	.1534262	.6349855
protection_service	.726829	.1588547	-1.46	0.144	.4735817	1.1155
_cons	2.95682	3.092532	1.04	0.300	.3806756	22.9665

Note: \_cons estimates baseline odds.

### 3.2. Third model for OVC DREAMS: we only included applicable variables for OVC DREAMS observations.

```
. logit BeneficiaryVaccinated_ Sex enrolled_School i.region AGYW_pregnant i.IP_n i.DREAMS_OVC_n active newcases Caregiver_Vaccinated_for_COVID i.Caregiver_Econo
> mic_Status_Clean health_Service protection_service LifeMentorship if OVCDREAMS==1, or
```

note: **enrolled\_School** != 1 predicts success perfectly;  
**enrolled\_School** omitted and 1 obs not used.

note: **active** != 1 predicts failure perfectly;  
**active** omitted and 1 obs not used.

note: **Sex** omitted because of collinearity.  
note: **3.DREAMS\_OVC\_n** omitted because of collinearity.

```
Iteration 0: log likelihood = -347.20456
Iteration 1: log likelihood = -283.7287
Iteration 2: log likelihood = -282.24571
Iteration 3: log likelihood = -282.23869
Iteration 4: log likelihood = -282.23869
```

```
Logistic regression                Number of obs = 510
LR chi2(19) = 129.93
Prob > chi2 = 0.0000
Pseudo R2 = 0.1871

Log likelihood = -282.23869
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]	
Sex	1 (omitted)					
enrolled_School	1 (omitted)					
region						
Manzini	5.914993	3.765018	2.79	0.005	1.698816	20.59501
Lubombo	1.351056	.8096443	0.50	0.616	.4174226	4.372914
Shiselweni	5.018274	4.411322	1.84	0.067	.8959924	28.10635
AGYW_pregnant	5.805244	2.353107	4.34	0.000	2.622969	12.84836
IP_n						
Bantwana	6.043602	4.199012	2.59	0.010	1.548434	23.58843
Cabrimi	4.763558	3.679713	2.02	0.043	1.0481	21.65012
Compassionate	1.490591	1.223868	0.49	0.627	.2981738	7.45157
Lusweti	.3848484	.324684	-1.13	0.258	.0736476	2.011039
NCM	.6477389	.5325642	-0.53	0.597	.1292858	3.245256
Worldvision	2.459233	3.225785	0.69	0.493	.1880508	32.16058
Young Heroes	21.48824	27.98554	2.36	0.019	1.673498	275.9157
DREAMS_OVC_n						
OVCDREAMS	1 (omitted)					
active	1 (omitted)					
newcases	2.22953	1.235824	1.45	0.148	.7523048	6.607432
Caregiver_Vaccinated_for_COVID	.5154166	.1161504	-2.94	0.003	.3313889	.8016388
Caregiver_Economic_Status_Clean						
Self-employed	.231926	.0893753	-3.79	0.000	.1089756	.4935936
Unemployed with income	.5380286	.1945088	-1.71	0.086	.2648975	1.09278
Unemployed with no income	.5038092	.2723214	-1.27	0.205	.1746508	1.453321
health_Service	.8480599	.2509443	-0.56	0.578	.4748458	1.514609
protection_service	.6089029	.129692	-2.33	0.020	.4010958	.9243743
LifeMentorship	.5701411	.1561056	-2.05	0.040	.3333665	.9750858
_cons	1.181905	.655697	0.30	0.763	.3984307	3.506

note: **\_cons** estimates baseline odds.

### 3.3. Third model for DREAMS: we only included applicable variables for DREAMS observations.

```
. logit BeneficiaryVaccinated_ Sex enrolled_School i.region AGYW_pregnant i.IP_n i.DREAMS_OVC_n active newcases LifeMentorship if Dreams==1, or
```

```
note: Sex omitted because of collinearity.
note: 1.DREAMS_OVC_n omitted because of collinearity.
Iteration 0: log likelihood = -1593.1517
Iteration 1: log likelihood = -1539.4146
Iteration 2: log likelihood = -1539.2118
Iteration 3: log likelihood = -1539.2118
```

```
Logistic regression                               Number of obs = 2,405
LR chi2(15) = 107.88
Prob > chi2 = 0.0000
Pseudo R2 = 0.0339
Log likelihood = -1539.2118
```

BeneficiaryVaccinated_	Odds ratio	Std. err.	z	P> z	[95% conf. interval]
Sex	1 (omitted)				
enrolled_School	1.300061	.1212962	2.81	0.005	1.082795 1.560922
region					
Manzini	1.325592	.2629381	1.42	0.155	.8986062 1.955465
Lubombo	.9296697	.1695843	-0.40	0.689	.6502166 1.329227
Shiselweni	1.18779	.4510722	0.45	0.650	.5642734 2.500287
AGYW_pregnant	1.022803	.2196496	0.10	0.916	.67142 1.55808
IP_n					
Bantwana	2.620266	.5166782	4.89	0.000	1.780331 3.856469
Cabrimi	1.56675	.3855158	1.82	0.068	.9672804 2.53774
Compassionate	1.356146	.3558072	1.16	0.246	.8109233 2.267949
Lusweti	1.020423	.2944397	0.07	0.944	.5796544 1.796353
NCM	.7492925	.2020773	-1.07	0.285	.4416621 1.271196
Worldvision	1.732736	.7805999	1.22	0.222	.7165805 4.189863
Young Heroes	2.237146	.6462787	2.79	0.005	1.269973 3.940887
DREAMS_OVC_n					
DREAMS	1 (omitted)				
active	.9076204	.1500279	-0.59	0.558	.656451 1.254891
newcases	.8523867	.6382249	-0.21	0.831	.1964713 3.698062
LifeMentorship	.6227225	.0730545	-4.04	0.000	.4948073 .7837057
_cons	.5347346	.1005297	-3.33	0.001	.3699245 .7729714

Note: \_cons estimates baseline odds.