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Surveillance Systems in Western Kenya: Methods, Perceptions, and Effectiveness

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SIT Study Abroad

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Acronyms:

AFI: Acute Febrile Illness

AFP: Acute Flaccid Paralysis

ARI: Acute Respiratory Infection

CDC: Centers for Disease Control and Prevention

CHV: Community Health Volunteer

CI: Community Interviewer

HDSS: Health and Demographic Surveillance System

HIV: Human immunodeficiency virus

KCDH: Kisumu County Department of Health

KCRH: Kisumu County Referral Hospital

KEMRI: Kenya Medical Research Institute

PBIDS: Population Based Infectious Disease Surveillance

PCS: Patient Care System

TB: Tuberculosis

WHO: World Health Organization

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Abstract:

Surveillance is an important tool in monitoring and evaluating infectious disease patterns and trends. Surveillance is vital because it aids public health officials and medical professionals in creating better prevention methods and efficiently managing outbreaks. Kenya is home to

many noncommunicable diseases making it an important location to conduct disease surveillance. Within Kenya, each county has its own surveillance unit which tracks and controls outbreaks. In addition, government run surveillance systems were established to determine disease burden, incidence, and patterns in specific at-risk communities around Kenya. One of these major surveillance systems is Population-Based Infectious Disease Surveillance (PBIDS) which has been following the communities in Asembo, Siaya, and Kibera informal settlement, Nairobi since 2005.

My research question was: What methods are employed in the surveillance of infectious diseases in Kenya? My attachment involved a mixed method approach where I learned about quantitative and qualitative methods for surveillance. I was able to successfully answer my research question by gaining an understanding of surveillance data collection methods used in Kenya at the facility, sub-county, and county levels, calculating crude incidence and adjusted incidence rates, determining the limitations and strengths of the methods used during surveillance, and understanding the impacts surveillance data has on health policy decisions.

I was attached to PBIDS to learn how their surveillance system is organized and what type of data they collect. I visited St Elizabeth Lwak Mission Health Centre and visited multiple villages within Asembo to learn about the PBIDS platform. Additionally, I worked with the lab and data analysis team to learn how data is collected from the field and eventually published. Further, I attached with Samuel Osure, from the sub-county surveillance department, to learn how surveillance works at the county, sub-county, and facility levels. Here I learned how wastewater samples are collected and what active case search is. By attaching with these surveillance programs, I was able to meet my objectives and gain an in-depth understanding of how surveillance in Kenya is conducted, the limitations to surveillance, and the effects surveillance has on implementing new health interventions.

Introduction:

Public health surveillance is the continuous, systematic collection, analysis, and interpretation of health-related data. This process serves the overarching goal of reducing morbidity and mortality while enhancing overall health. In Kenya, where communicable diseases stand as the leading causes of death and require the highest amounts of funding, it is imperative to understand what populations are at risk and how to reduce communicable disease burden.

Western Kenya is of specific interest for surveillance and health efforts because of its high infectious disease prevalence and low economic status. Accurately estimating and characterizing infectious diseases in Kenya is important when allocating resources for health interventions and prevention measures.

Two regions were examined in this investigation: Kisumu and Siaya County. Both Kisumu and Siaya are endemic to Malaria and have some of the highest HIV prevalence rates in the country. HIV prevalence among adults in Siaya and Kisumu is 15.3% and 16.9%, respectively. Both counties have an HIV prevalence rate that is about three times higher than the national average of 4.9%. Kisumu County is more urban than Siaya and has an estimated population of 1,280,88 compared to 993,183. Because of their high prevalence of infectious diseases and their close location to my residence, these two counties were examined.

The Kisumu County Department of Health (KCDH) has a County Medical Laboratory: that collects, analyzes, interprets, and disseminates information to Kisumu County Officials and the National government about diseases that are affecting the population. They specifically track diseases that the World Health Organization (WHO) is targeting for eradication: Measles and Acute flaccid Paralysis (AFP). Sub-county surveillance officers specifically do active case searches for infectious diseases and conduct outbreak investigations when needed. During my attachment, I worked with the sub-county surveillance team to do an active case search for Measles and AFP. I did so by visiting facilities and doing active case search and aided in collecting samples from wastewater to search for AFP within the population. While attaching with the sub-county surveillance offices I learned about Kenya Health Information Systems (KHIS). KHIS works as a common source that health providers and officials can use to report, analyze, and prevent the spread of diseases and health conditions at facility, sub-county, and county levels. The overall goal of my time with the sub-county surveillance team was to learn how surveillance data is collected at the facility, sub-county, and county levels. Furthermore, I was analyzing the effectiveness of their surveillance system, the ways in which they could be improved, and how surveillance data impacts the introduction of health interventions.

Siaya County is participating in a unique surveillance study, PBIDS. Typically, surveillance studies occur at healthcare facilities, however, this does not provide an accurate analysis of disease burden or incidence in low-middle-income countries. In low-middle-income countries, many individuals do not seek medical aid at health facilities, making it hard to accurately determine disease burden and incidence. To run a more efficient analysis of infectious diseases, PBIDS was created. PBIDS strives to monitor disease burden and determine the aetiology of common infectious diseases within communities in Kenya by collecting health data at facilities and homesteads. Surveillance data is collected two to four times a year, depending on funding, and collects information about demographics, socioeconomics, health status, and healthcare-seeking data. There are two locations of PBIDS in Kenya one is based in Asembo, Siaya and the other is in Kibera informal settlement, Nairobi. The data PBIDS collects measures the impact and effectiveness of public health interventions to reduce infectious disease burden. This investigation specifically focused on PBIDS in Siaya. In Siaya data is collected at St Elizabeth Lwak Mission Health Centre and participants are enrolled from 33 villages within Asembo. PBIDS focuses on characterizing acute respiratory infections (ARI), Acute Lower Respiratory Infection (ALRI), diarrhea, and acute febrile illness (AFI). Within the ongoing research of PBIDS, I was interested in learning how to calculate adjusted incidence rates, what limitations their surveillance system faces, and the effects of the surveillance system on health interventions.

Research Question: What methods are employed in the surveillance of infectious diseases in Kenya?

Objectives:

1. Gain an understanding about surveillance data collection methods used in Kenya at the facility, sub-county, and county levels
2. Learn how to calculate crude incidence and adjusted incidence rates
3. Determine limitations and strengths to the methods used during surveillance
4. How surveillance data impacts health policy decisions

Justification:

Population-based surveillance and facility-based surveillance are vital methods to collect information regarding infectious disease spread. Without surveillance officers or surveillance projects it would be difficult to determine when an outbreak occurs, if treatments are successful, and what demographic characteristics make someone at risk for disease. This area of research is specifically relevant in Kenya due to the presence of numerous infectious diseases with a significant impact on the community. Because of longitudinal surveillance studies, years' worth of data is collected making early outbreak detection possible, reducing disease spread and deaths, and reducing the cost of the outbreak management. Additionally, disease surveillance is beneficial in determining what policies public health officials should be introducing to reduce the spread of infectious diseases and reach WHO health standards. Surveillance is vital because it provides healthcare workers with demographic and disease information which can help them treat and diagnose the population effectively and efficiently. Additionally, surveillance aids public officials in creating policies to help reduce disease burdens and put into place prevention methods to reduce the spread of future diseases.

Ethics:

While on attachment, it was important to consider the ethics of my actions and the data I was collecting. I drafted a comprehensive research proposal and successfully obtained approval from the Institutional Review Board (IRB). The approval signifies that the proposed research methodology aligns with ethical standards and ensures the protection and well-being of research participants. During my attachment with KCDH and PBIDS, I was working with both primary and secondary data. While with PBIDS I was given access to quantitative data by data analysts. This data was secondary because it had been previously analyzed and had all names or identifying characteristics removed from it before I was given access to it. This ensured that all research participants identified remained confidential.

There were times during my attachment when I was working with logbooks and survey tools that did include individuals' names and health data. To ensure patient confidentiality I excluded patient details in any notes that were taken. Additionally, I was involved in research interviews. Before the interviews began, I gained verbal consent from the participants to be present during the interview.

All individuals who are enrolled in PBIDS have signed written informed consent for data collection at their households and clinics. For all minors, written informed consent was obtained from their legal guardian or parent. Furthermore, before any clinical procedure or interview verbal consent is sought before treatment, or the interview begins. The PBIDS protocol was approved by the Ethical Review Boards of KEMRI and the Centers for Disease Control and Prevention (CDC).

Literature Review:

PBIDS

In Kenya, the CDC and KEMRI have established two population-based infectious disease surveillance networks with the key objectives of establishing disease burden, the causes of these diseases, and implementing and evaluating health interventions. The rural surveillance site is based in western Kenya at Lwak Health Center and participants come from 33 villages within Asembo, Siaya. Lwak covers almost 80 square kilometers and has a population density of 320 people per square kilometer (PBIDS, 2021). The second surveillance site is the two villages Gatwekera and Soweto West in Kibera informal settlement, located in the urban city of Nairobi. Kibera covers 0.37 square kilometers and has a population density of 70,000 people per square kilometer (Bigogo, 1970). Two surveillance sites were established to compare the health risks of living in both an urban and rural environment. In 2010 the Kenyan government devolved from a central government system to county governments (Bigogo, 1970). This means that the provision of services such as health, clean and safe water, and road networks are functions of county governments. This has led to increased health disparities between rural and urban regions within Kenya.

PBIDS is a longitudinal surveillance system. Longitudinal surveillance systems are beneficial because they collect data year-round, for multiple years, allowing data to be collected about healthcare seeking over time and by season (Bigogo, 2010). Diseases vary by year based on the pathogens that are circulating. Additionally, diseases vary by season. For example, during the rainy season, there are more cases of Malaria because there is more stagnant water in the region increasing the breeding ground for mosquitoes. On the other hand, one-time surveys provide only a snapshot of health-seeking behavior (Bigogo, 1970). This is inaccurate and leads to incorrect extrapolation of data when it is known diseases vary over time. Also, a longitudinal study ensures familiarity between the interviewers and participants. The trust that is built between the two reduces biases and the need to give “correct” answers. Additionally, population-based surveillance is important because most data is hospital-based. In countries where hospitals are not easily accessible population-based data is not representative or accurate of disease burden in certain regions or the country as a whole. Collecting data at the facility and homestead ensures data is more representative of the entire community and results in more accurate incidence calculations (Bigogo, 1970).

Finally, PBIDS is an important system because it assesses the impact of new and existing public health interventions. When health interventions like vaccines, sanitation programs, or non-pharmaceutical (promoting bed nets) are introduced it is often difficult to determine the impact they have on disease incidence. However, when interventions are established at one of the two PBIDS sites it allows for comparisons to be made between the incidence of disease before and after the introduction of the new intervention. The effects of the intervention can then be analyzed and shared with public health officials. For example, Rotavirus is a large cause of mortality in children <2 years of age (Breiman, 2014). It is important to determine disease burden to determine methods to reduce its prevalence and the efficacy of rotavirus vaccines and immunization programs. During the PBIDS study, it was found that in the Lwak surveillance area 11.4% of patients presenting with diarrhea had rotavirus and in Kibera 7.8% of patients presenting with diarrhea had rotavirus (Breiman, 2014). This data was used to adjust the incidence rates to better estimate cases for people living in similar locations. It was also found that rotavirus is a large cause of gastroenteritis in adults in similar settings in Kenya (Feiken, 2011). Finally, it was determined that Rotavirus incidence rates varied substantially over the course of the study. Understanding the characteristics of Rotavirus allowed scientists to accurately determine the efficacy of the new Rotavirus vaccine (Breiman, 2014). Because of their previous research, it was found that the Rotavirus vaccine was successful at reducing disease incidence by 98% in severe Rotavirus infections (CDC, 2021). The data collected from PBIDS can be used when trying to provide medical aid to regions in Kenya that share similar characteristics to Asembo and Kibera. This can be helpful when determining where interventions should be implemented and the economic impacts of said interventions.

The Big Three

TB, Malaria, and HIV are considered the three deadliest infections. The big three are the leading cause of infections and deaths yearly in Kenya, making them a major global public health issue. Despite their prevalence in Kenya these three infectious diseases are hard to collect proper surveillance data making it harder to treat and reduce disease burden.

TB

According to WHO, Kenya is listed among the top 30 high-burden TB states in the world. Within Kenya, TB is the 4th leading cause of death (Enos, 2018). To control TB three challenges must be overcome: the ability to identify and diagnose cases, the creation of better, shorter, treatment regimens, and better longer-lasting TB vaccines (Andrew, 2012). One of the main challenges with identifying and diagnosing TB is the fact that it is underreported and contact tracing is difficult. Many facilities in Kenya are unable to run diagnostic tests required for TB, so many patients are left undiagnosed and untreated. Additionally, Kenya had not run a national TB prevalence survey since 1958 and was using estimates from WHO to determine TB incidence and case detection rates (Enos, 2018). To determine more accurate incidence and case detection rates Enos et al., created a cross-sectional survey where participants underwent TB testing and chest X-rays. The study found that TB prevalence was 558 per 100,000, indicating that prevalence was much higher than expected (Enos, 2018). Additionally, they determined that over half of the population that has symptoms are missed each year. However, to increase surveillance in Kenya this requires high costs and resources that are not readily available. Another obstacle to treating TB is the development of multidrug resistance TB (MDR-TB) and the inability to adhere to medication. When a patient is treated for TB, they need to take antibacterial medications for a period of six to twelve months (Park, 2012). However, many individuals do not adhere to the medication regimen which often leads to relapse and MDR-TB.

Malaria

Malaria is a vector-borne illness that is endemic to many parts of Kenya. In Kenya, it is estimated that ~4000 people die annually from malaria, most of whom are under the age of five (Elnour, 2023). Malaria is spread through the Anopheles mosquito which thrives in hot and humid climates that are at lower elevations. As a result, 70% of the population is at risk for malaria (KNBS and ICF, 2023). It is difficult to reduce the malaria burden because climate change is increasing the burden, access, and use of nets are not effective, and drug resistance is increasing. As climate change worsens it will increase the flooding which occurs in Kenya, increasing the breeding ground for mosquitoes. Additionally, more regions within Kenya will be habitable for the anopheles mosquito to reproduce and thrive. This means that Malaria will become endemic to more parts of Kenya resulting in higher infection rates (Ryan, 2020).

Another issue facing appropriate Malaria treatment is the misuse of insecticide-treated bed nets (ITN). The deployment of ITN has proven to be successful at controlling malaria. However, the effectiveness of ITNs decreases when vulnerable population's re-purpose or do not use them. A study in Kenya found that 30% of bed net recipients did not properly use them (Kokwaro, 2009). Many fishing villages use nets for fishing and drying fish. Additionally, they are used in agriculture to protect their crops from bugs. Finally, anti-malarial treatments are becoming less effective because they are being overused. Since Malaria is so common in Kenya antimalarials are available over the counter and are often used whenever an individual has a fever. This is leading to decreased efficacy of antimalarials and there are many cases of drug resistance appearing because they are being overused. Additionally, because of over-the-counter usage of antimalarials, it is difficult to gauge the number of individuals who have become infected with Malaria yearly.

HIV

HIV has been an epidemic in Sub-Saharan Africa for over 30 years and currently 1.4 million Kenyans are living with HIV (UNAIDS, 2023). There is currently no cure or effective vaccine for HIV, the main treatment for HIV is antiretroviral therapy (ART). ART has decreased HIV-related deaths in Kenya by 32% (Kharsany, 2016). Even though there has been expanded HIV care and treatment available in Kenya, HIV remains one of the leading causes of death and only 71.6% of the population has a suppressed viral load (Conan, 2021). HIV continues to be a large issue in Kenya because it remains heavily stigmatized, with high rates of gender-based violence, and lack of sexual education. Stigmatization of HIV makes surveillance difficult because there are high levels of underreporting. This is specifically an issue in high-risk populations such as men who have sex with men, people who inject drugs, and sex workers. While these groups are at an increased risk of infection, they are unlikely to access HIV treatment or prevention services because of the discrimination and stigma they face from society. Additionally, due to the stigmatization of HIV, many individuals who have HIV symptoms will not get tested for HIV. This leads to higher rates of HIV-related deaths and the continued spread of HIV throughout communities. Another issue in controlling the HIV epidemic in Kenya is the fact that women have a disproportionately high HIV burden compared to their male counterparts (KNBS and ICF, 2023). This is due to the lack of appropriate interventions to protect young women against GBV and provide them with appropriate sexual education. Furthermore, of individuals diagnosed with HIV, less than half receive appropriate and effective treatment and 30% of those on ART do not maintain viral suppression (Kharsany, 2016). Undiagnosed HIV infection and inadequate viral suppression are the two major factors limiting control over the HIV epidemic.

Methodology:

The goal of this investigation is to understand how surveillance data is collected and the limitations and strengths of Kisumu County and PBIDS surveillance methods. To begin this project, I will conduct preliminary research about surveillance procedures that are occurring in Kisumu County and PBIDS. Specifically, the goal is to gain an understanding of PBIDS in terms of the data they collect, resources available, community perceptions, outcomes, and procedures. I will then contact hosts at Kisumu County Referral Hospital (KCRH) and PBIDS to determine the best time to shadow staff and go into the field. Before I can begin any sort of surveillance work it is vital to gain authorization from Kenya Medical Research Institute (KEMRI) to work for PBIDS and view health records regarding surveillance data. When I am dealing with health data, I must consider patients' privacy and confidentiality. I can do this by anonymizing or de-identifying the data I am working with and not disseminating information to others. While attaching with PBIDS it would be beneficial to work with CIs to analyze their collection methods and the effects data collection has had on the county's health and educational practices. Additionally, I would like to work with KCRH to learn how surveillance data is collected at the sub-county and county levels in Kisumu. I then plan to determine the limitations and strengths of their surveillance system. Additionally, after collecting data with PBIDS, I will determine the incidence of diarrhea in children under the age of 5 from 2018-2022 in Asembo and Kibera. This will represent how common diarrhea cases occur in children, how frequency has changed over the period, and allow for analysis to determine who is most at risk. Additionally, I will determine the limitations and strengths of PBIDS methods. To further my understanding of surveillance in Kenya I will be journaling and discussing my experiences with my peers at School for International Training (SIT). Journaling will allow me to track my learning progress and determine if I am meeting my objectives promptly. Discussions with my peers will be beneficial because they will broaden my understanding of the impacts of surveillance by understanding how it applies to a broader context such as policy, gender rights, and overall health equity.

Setting:

The current PBIDS study is based out of KEMRI in Kasian. Field surveillance is occuring in Asembo, Siaya. The health facility in use is St Elizabeth Lwak Mission Health Centre. KCRH is based in Kisumu County. Other facilities within Kisumu East sub-county were visited.

Study Population:

The population for PBIDS are the residents of the 33 villages enrolled in HDSS in Asembo, Siaya. The population at KCRH is anyone who visited the facility or other facilities in Kisumu East sub-county.

Incidence Calculations:

To calculate incidence the first measurement Person Years of Observation (Pyo) must be determined. Pyo is how long a participant has been involved in a study in years. Pyo is the sum of the differences between the start and end date of residency divided by 365.2 days. Start date is determined by childbirth (if the mother is a PBIDS participant), date of enrollment into PBIDS, date of readmission, study start date, or the 1st interview date. The stop date is based on death, out migration, studies stop date, nobody home for 4 consecutive months, or a withdrawal from the study. The key component of Pyo is that individuals can have multiple start and stop dates. After Pyo is determined Crude Incidence Rate is calculated. Crude Rate is the estimated rate of diarrhea cases treated at Lwak Health Center or Tabitha Clinic. It is calculated using the following equation.

$$Crude\ Rate = \frac{\#\,Cases}{PYO} \times 1000$$

The next step to calculating adjusted incidence rate is determining the rate adjustment factor. Rate adjustment is used to account for missed cases due to gaps in case detection and diagnosis at the clinic. We used rate adjustment to determine the percentage of people who had diarrhea symptoms during home visits who visited clinics other than Lwak Health Center or Tabitha Clinic. Adjusted Incidence is determined using the following calculations.

$$Adjusted\ Cases\ = \frac{\#\, patients\ visited\ Lwak}{Total\ \#\, patients\ visited\ any\ Clinic}$$

$$Adjusted\ Incidence = \frac{Adjusted\ Cases\ 2}{PYO} \times 1{,}000$$

Confidence Intervals were also determined using the Poisson confidence limits method.

Crude Incidence Confidence Intervals

$$Lower\ 95\% = \frac{rate}{exp(\frac{1.96}{\sqrt{\#\, cases}})}$$

$$Upper\ 95\%\ =\ rate \times exp(\frac{1.96}{\sqrt{\#\, cases}})$$

Adjusted incidence Confidence Intervals

$$Lower\ 95\% = \frac{adj\ rate}{exp(\frac{1.96}{\sqrt{\#\, adj\ cases}})}$$

$$Upper\ 95\%\ =\ adj\ rate \times exp(\frac{1.96}{\sqrt{\#\, adj\ cases}})$$

Observations during the Internship:

PBIDS

PBIDS is a very organized system that depends on each sector: Asembo, Lwak Health Center, KEMRI lab, and data analysis to be functioning at a high level. During my attachment I spent time at each sector learning how they are organized, interacted, and depend on each other.

Asembo is important in terms of having a population to examine. Without Asembo, there would be no participants in PBIDS clinical research. Asembo allows for incidence within the community to be determined. Incidence is determined by asking participants two to four times per year if they have experienced any illnesses within the last 2 weeks. CIs report on what symptoms each participant has experienced, if the individual received treatment: if yes where and what the diagnosis was, and if an individual has a chronic illness. Normally, incidence is determined at the facility level, but most people in Asembo do not visit Lwak Health Center because it is too far away. Therefore, incidence rates end up being inaccurate for the community’s actual disease burden. While conducting interviews for PBIDS, CIs collect other survey data such as HDSS, snakebite reports, and information on water sanitation. Additionally, CIs can track interactions between participants by creating social groups. Social groups indicate who and where people are eating meals. Social groups allow PBIDS to track who is interacting with who. CIs use HDSS to determine mortality, births, and migrations within the community. Furthermore, they report on the vaccine records for children under the age of five. HDSS data is used to double-check PBIDS data and determine if any errors were made during the interview. Additionally, the HDSS is used to enroll participants into PBIDS. Once a participant has consented to PBIDS research they are given a unique HDSS ID number based on their village-compound-structure number. This HDSS ID is then used when an individual visits Lwak Health Center.

Lwak Health Center is vital for treating patients who present with infectious disease symptoms. Without Lwak Health Center, there would be little benefit for participants to enroll in PBIDS research. If an individual presents with an infectious disease at Lwak Health Center, they are treated free of charge. This benefits the community because over 70% are below the poverty line and have trouble affording health care. When individuals enter Lwak Health Center they provide the clerks with their HDSS ID number which is then used to generate a unique visit ID number within the Patient Care System (PCS). PCS is a database that allows every department within Lwak Health Center to input data regarding a patient's case. For example, the clinician can write a diagnosis for the patient which tells the nursing staff which samples need to be taken. Each sample is then labeled with a unique barcode which allows the sample to be linked to the individual in the PCS system which can then be viewed within the Lab Master databases at KEMRI.

After a sample has been taken at Lwak Health Center, they are then transported to the KEMRI lab in Kasian. The lab determines what illnesses are circulating around the community by identifying the type of pathogen or bacteria present in a sample, sequences pathogens (COVID, pneumonia, and Flu), and determines the presence and severity of antibiotic resistance. Sample testing at Kasian is used to improve medical diagnosis at Lwak Health Center. If a sample tests positive for a specific pathogen or antibiotic resistance for the prescribed medication occurs, then the results are shared with Lwak Health Center and a new prescription is written.

The last step within PBIDS is data analysis. Data analysis allows for the complete synthesis of all the data that has been collected through the PBIDS platform. At the data analysis stage, data collected from the clinic, village, and lab are linked together and any errors are fixed.

With this data, scientists can request data to write manuscripts and reports that can influence health policy decisions or indicate the effects of health interventions like vaccines, water sanitation, and bed-net dispensation.

Kisumu Surveillance

The surveillance system in Kisumu differs significantly from that implemented at PBIDS. It is organized into three distinct tiers: facility, sub-county, and county levels, each with designated roles in the surveillance process.

Facilities are where surveillance data collection starts. Facilities treat patients and determine if individuals are showing any symptoms of major infectious diseases identified by WHO. These infectious diseases include but are not limited to AFP, measles, malaria, TB, cholera, rabies, and anthrax. Depending on the facilities level, diagnostic testing can be done to accurately diagnose a patient within the facility. However, the majority of facilities within Kisumu lack the testing capacity to test for these infectious diseases. As a result, samples are taken to another facility, or a diagnosis is given without lab confirmation. Additionally, facilities report to the sub-county if a patient matches any of the case definitions for the aforementioned illnesses. The facility subsequently generates weekly reports detailing the quantity and types of diagnoses and tests conducted. These reports include information on the positivity rate of the tests and provide an age breakdown of the identified diseases.

The majority of surveillance run within Kisumu County is based on the work that occurs at the sub-county by the sub-county surveillance officers. Sub-county surveillance officers are responsible for doing active case searches at every facility within their region. Active case surveillance requires sub-county officers to check the outpatient register at facilities to determine if the correct diagnosis was given or if a possible infectious disease case was missed. If a case is missed the surveillance officer will follow up the patient and collect samples if that is viable. Further, if there are clusters of illnesses the surveillance officer will begin an outbreak investigation and try to resolve any issues. Further, they run passive surveillance by testing wastewater for AFP, COVID-19, and other infectious diseases. These wastewater samples are shipped to KEMRI in Nairobi to be tested. If there are positive samples the surveillance officer has to determine what communities are at risk and if any health interventions need to be put in place. Lastly, they oversee ensuring every facility writes and submits a weekly report of the tests they have run and diagnoses they have given to patients. Subsequently, these reports are delivered to the county for the purpose of tracking and monitoring.

The role of the county is mainly to supervise the sub-county and organize surveillance events. County surveillance officers' main role is to assign sub-county surveillance officers to their posts and supervise any disease outbreak investigations by providing extra personnel or getting international organizations involved. Another crucial role they have is being spokesperson for the community and various stakeholders. In the event of an outbreak investigation, the county takes on the responsibility of delivering health messaging to the community and implementing any necessary protective measures. Moreover, they act as a liaison between various organizations to plan collaborative events such as World Rabies Day, World AIDS/HIV Day. The latest initiative led by the county was the observance of World Rabies Day. In collaboration with agricultural and wildlife management, the county facilitated the administration of rabies vaccinations to dogs in Seme. They also partnered with the Red Cross to conduct educational campaigns on rabies awareness. Notably, county surveillance officers identified a significant challenge in distributing rabies vaccines throughout the county, particularly in rural areas. To address this issue, they collaborated with multiple drone companies to coordinate the aerial transportation of rabies vaccines to remote health facilities.

Analysis of Internship:

PBIDS Analysis

After spending multiple weeks visiting Lwak Health Center, Asembo, and KEMRI it was discovered that the PBIDS platform exhibits both strengths and limitations. Most of these observations were pointed out by members of PBIDS. These observations were then synthesized and combined based on the three major sections of PBIDS: Lwak Health Center, Asembo, and the KEMRI lab.

The main issues that Lwak Health Center faces are lack of resources and understaffing: making it hard to accurately treat all their patients. In Lwak Health Center Clinicians do not have access to basic medical tools like stethoscopes or blood pressure cuffs for children. When I visited Lwak Health Center doctors mentioned that because of the lack of these instruments they had to change the vitals they took when someone entered the facility. Also, one doctor used his own phone as a flashlight to check someone's ears and throat. With a lack of medical supplies, it can be hard to accurately treat a patient. Additionally, the health center is understaffed for the population being served. It is not uncommon for patients to wait multiple hours before they see a physician and get their prescriptions. To reduce the issues Lwak Health Center faces, PBIDS requires more funding. Funding is an issue that PBIDS has been facing since its inception and will continue to face, making it challenging to address these issues. Further, Lwak Health Center is not run nor staffed by PBIDS but is run by the health center itself. This makes it difficult to resolve issues related to staffing. However, according to PBIDS team members it is possible to invest in equipment like child blood pressure cuffs and other tools such as Otoscope pens to ensure that correct diagnoses are being made.

Despite these limitations to care, Lwak Health Center is providing treatment in a novel and effective way. The most noticeable difference between Lwak Health Center and other health facilities is its online database, PCS. Most facilities in Kenya primarily depend on paper, which leads to a variety of issues. However, the PCS system at Lwak Health Center streamlines the entire care system ensuring patients are not given medication that is not available, makes it easy to determine who is part of the PBIDS system, and patients know before treatment how they are expected to pay. One of the largest pros to the PCS system is the fact that the pharmacy can input what medications are in stock and what are not. In many health facilities individuals are expected to bring their own medication or buy it at another facility. However, at Lwak Health Center, only medication in stock is prescribed, reducing the amount of time and money patients must go through to receive their medication. Another benefit of PCS is its relative ease of use. PBIDS participants are color-coded based on their status. Red indicates that a patient has died, Yellow means a participant is not active, and green indicates that a participant is active and will be treated using the PBIDS protocol. Such ease allows clerks to determine if a patient can be treated using the PBIDS protocol. Additionally, at the beginning of the care process, patients are informed if they qualify for PBIDS to cover their health costs, or if they must pay using health insurance or out-of-pocket. This ensures that patients go into the health center knowing how much they are expected to pay, rather than being blindsided by the cost at the end. Not knowing what the expected healthcare costs are is a major issue many patients in the United States face when they are seeking care. Another novel idea that Lwak Health Center is implementing is providing free care to participants of PBIDS who present with non-communicable illnesses. Ensuring participants of PBIDS receive free care makes PBIDS a beneficial study for participants and vice versa. When PBIDS covers care participation in the study area increases which makes data more accurate. The community benefits as a whole because health interventions can be analyzed and implemented. For example, PBIDS participants are the first to receive new health interventions like vaccines and bed nets. The participants of PBIDS who live in Asembo are the majority living under the poverty line. Before PBIDS was implemented, this community was majorly underserved in terms of health care. While it would be beneficial for PBIDS to cover all participant's illnesses and injuries, it would not be cost-effective for them and ultimately a smaller population would benefit from the study. While Lwak Health Center lacks many of the basic tools necessary to treat patients, the facility is providing novel care to an underserved community.

Asembo faces many limitations when it comes to its lack of reliable technology and geographical constraints. The major issue Asembo faces when collecting data is the lack of updated technology and difficulty visiting participants. Asembo is situated in rural Kenya, where access to the internet and power is limited in certain areas. This is an issue for CIs collecting data because their entire interview is done via tablet. CIs upload their survey data on Mondays, which requires the entire day due to unstable internet and the large quantity of data. Another major issue for CIs is the bugs that come when the database is updated. For example, a recent update made it so all vaccine records for children who were close to the age of five were deleted. This requires CIs to manually enter all the vaccine information again. Also, while recording vaccine data, a picture of the vaccination booklet is required. There have been numerous issues with tablets being unable to take pictures. Both issues increase the time a CI spends at a compound and increase their workload. Another issue that CIs face in terms of data collection is the inability to reach compounds. The majority of the roads in Asembo are dirt, and during the rainy season, the roads can be impassable, making it impossible for CIs to conduct interviews. Also, PBIDS covers a radius of 5km and many of the villages are widely spaced away from each other. The geography of Asembo makes it very difficult to interview multiple compounds daily, making it hard to interview the entire population in the allotted time. To reduce the impact of these limitations, PBIDS would require government funding to increase internet access or more funding from KEMRI to get new technology. However, PBIDS could help the community invest in road repair operations that use recycled materials such as recycled asphalt pavement, recycled concrete aggregates, or gravel. This would help the community twofold, increasing road reliability would allow for easier movement for people and could increase the percentage of people seeking care at Lwak Health Center because it would be easier to reach the facility.

Establishing and nurturing strong relationships between CIs and PBIDS participants is crucial for the accurate and effective collection of data. Most participants in PBIDS know all the CIs in Asembo. The trust that is built between these two eliminates bias during interviews and reduces the participant's perception to provide interviewers with accurate answers. Collecting data at the homestead ensures that data accurately represents the individual and the entire community. Collaborating with the community ensures that the research PBIDS is conducting is culturally sensitive, addresses local issues, and ensures that research is relevant. Additionally, the trust that CIs have built with the community reduces misconceptions about infectious diseases and helps communities accept scientific recommendations. Communities are more likely to accept and adopt health recommendations from people they trust, and public acceptance is required to implement effective health policies. Another positive aspect of data collection in Asembo is the fact that CIs can collect a lot of demographics, health status, and health-seeking data in a short period. During one interview a participant can provide data for HDSS, PBIDS, water sanitation projections, and other surveillance efforts. By collecting so much data, many different variables within Asembo can be analyzed and hopefully improved by health and government officials. The challenges faced by CIs in Asembo, stemming from its geographical and rural location, are significant. Nonetheless, the importance of thorough data collection during each interview, coupled with the accuracy of trust that CIs have helped establish, cannot be overstated.

The last major component of PBIDS is the lab based at KEMRI. The major limitations the lab faces are a lack of proper transportation equipment and a high volume of samples. When samples are transported from Lwak Health Center to KEMRI they are transported in coolers that contain ice packs. Samples are supposed to be transported at 4-8°C to ensure their viability. However, there is no internal thermometer to track the temperature of the samples and it has been found that samples often arrive at temperatures higher than what is recommended. Additionally, samples often arrive with only 1 ice pack within the cooler which does not ensure equal cooling of the sample. This is a limitation of PBIDS surveillance because the quality of samples cannot always be ensured. If samples are being transported at incorrect temperatures, this could affect the accuracy of results when samples are tested. Samples stored at too high a temperature can lead to protein degradation, microbial contamination, or changes in enzyme activity. Improper sample storage can compromise the accuracy of results. Another issue the lab faces is having to intake Serum samples. The PBIDS protocol requires serum samples to be taken for COVID-19 sequencing or for future aetiologic and serological tests. However, there is no immediate testing upon sample intake. Serum samples are delivered to the laboratory to be kept frozen in freezers for an indefinite period of time. Laboratory personnel are uncertain about the rationale behind the collection and delivery of serum samples, especially considering that they have not undergone testing at KEMRI and have been dispatched to CDC Atlanta only once. KEMRI receives samples from facilities in Kisumu County, neighboring counties, and other research studies being run in Kenya. This leads to a high quantity of samples that need to be tested in a very tight time frame. Aliquoting serum requires much-needed time and resources that could be better spent testing other samples. To reduce the issues being faced in the lab there are a few possible solutions. To ensure samples are kept at the same temperature, coolers should be equipped with thermometers that can track the temperature inside the cooler. This would allow the lab to determine if samples are being transported at temperatures higher than recommended. If the samples are frequently reaching temperatures outside of the recommended, KEMRI and CDC should invest in coolers that regulate temperatures. To mitigate challenges related to serum samples, PBIDS should communicate the necessity of serum sample collection to laboratory staff, aiming to minimize any misunderstandings. Furthermore, it is advisable to reevaluate the protocol to determine if serum samples are an indispensable component of the experiment.

While the lab faces a few issues, they are conducting high-quality work and can conduct a wide range of tests. KEMRI is a highly qualified institute to be running PBIDS. Their staff is well-trained, and they have access to state-of-the-art machines. Well-educated laboratory staff can interpret data efficiently and effectively, ensuring errors are identified and rectified promptly, minimizing the risk of any inaccuracies. High-quality machines ensure precise and accurate results are produced, reducing false positives or negatives. High-quality personnel and machines are essential components of effective disease surveillance. They contribute to the accuracy, reliability, and ethical conduct of surveillance activities, enhancing the study's ability to monitor and analyze data.

Even though PBIDS faces resource constraints in its pursuit of an optimal infectious disease surveillance program, the significance of its work cannot be understated. PBIDS plays a pivotal role in collecting vital information about communities that are most vulnerable to infectious diseases, significantly reducing the burden they face. Moreover, PBIDS is actively alleviating health issues within the community by facilitating access to innovative health interventions, including prioritized distribution of vaccines and the implementation of novel treatments for diseases such as malaria.

Kisumu Surveillance Analysis

During my attachment with Samuel, a sub-county surveillance officer, I gained valuable insights into the intricacies of surveillance conducted at the facility, sub-county, and county levels. This experience deepened my understanding of the surveillance process, shedding light on the challenges and strengths that encountered when conducting surveillance in Kenya.

The majority of limitations to the current surveillance method in Kenya are due to a lack of funding from the government and access to resources. The first thing I learned from my attachment is the underreporting of diseases that occur in facilities, especially dispensaries and level-three health facilities. Underreporting is a large issue in Kenya that makes it difficult to determine the disease burden and understand what communities are at risk. The main illness that is underreported is TB. The main reason for this is due to facilities lacking equipment such as GeneXpert. Facilities that are unable to test for TB are supposed to send samples to another facility for testing or refer the patient to a facility that has TB testing capabilities. However, samples are infrequently sent to other facilities due to lack of resources or personnel. Furthermore, facilities that are capable of testing for TB are often out of the reagents and supplies required to test for TB, resulting in samples just being thrown away. Patients are also unlikely to visit another clinic on referral because the facilities are often located farther from their home, cost too much, or do not wish to be tested for TB due to the stigma surrounding TB diagnosis. This leads to the increased underreporting of TB cases and is spurring the MDR-TB epidemic. Another reason for the underreporting of infectious diseases is that communities lack appropriate knowledge about when to visit a health facility and how to appropriately take medication. While there are CHVs to aid in this process, these CHVs do not have enough resources to cover all the communities in need or spend enough time to cover every topic that is important in understanding infectious disease management and treatment. To reduce the underreporting seen in Kisumu and the other counties in Kenya, the national government needs to ensure that facilities are well-equipped to handle infectious disease testing. By providing resources to facilities that are testing infectious disease samples, and increasing the number of facilities that can run infectious disease tests. Another way to increase accurate reporting would be to create a system within Kisumu County to ensure that samples are picked up from facilities that are unable to run tests and brought to facilities that can run samples. This could involve hiring a driver who picks samples daily and drops them at facilities with the capability to run samples, and then dropping results at the original facility for patients to easily access their test results. Such measures would not only contribute to improved reporting accuracy but also promote efficiency in the healthcare system.

Another limitation that surveillance officers face in Kisumu is working with a paper-based platform. In Kisumu, all the facilities within a sub-county are required to send in a weekly report to their sub-county surveillance officer and every facility does this via paper. This poses a significant challenge as papers are frequently lost, and reliable backups are not consistently maintained. In cases where a paper is misplaced, facilities may fail to submit a completed weekly report to the sub-county. Even when submitted, these reports often contain incomplete information in various columns. This issue undermines the accuracy of surveillance, impacting the effectiveness of the overall monitoring process. Furthermore, paper reporting leads to increased errors due to illegible handwriting and increased bias in reporting. Surveillance officers do active case searches at over 100 facilities every month. Active case search requires surveillance officers to go through facility outpatient logbooks and analyze the diagnosis, symptoms, and locations recorded. However, the outpatient facilities are often overcrowded, and receptionists are rushed to write down patient information. This leads to reports that are nearly impossible to read or incompletely filled out. Therefore, surveillance officers have to make educated guesses on what they are reading, which inevitably leads to bias and underreporting. Furthermore, the lack of standardized record-keeping practices across different facilities exacerbates this issue. The absence of a uniform system makes it challenging for sub-county surveillance officers to seamlessly compile reports, as they must contend with disparate data structures. This not only compromises the efficiency of the reporting process but also imposes additional time and effort burdens on sub-county surveillance officers. Lastly, the absence of an electronic data system results in patient records being dispersed across various locations, inaccessible to all healthcare providers from a centralized platform. This means every time a patient visits a facility, they are given a unique case number, but there is no facility knowledge of their health history. This is a limitation in terms of surveillance because this allows for patients to be double counted. If a patient visits a facility for Malaria and is given treatment but then visits another facility for that same diagnosis of Malaria, both facilities would report a Malaria case, leading to misrepresentation of some illnesses. While online record keeping is not a viable option for many facilities within Kisumu it would be beneficial to linearize data keeping so all facilities report with the same tools and the same method. Implementing a unified approach where all facilities report using the same tools and methods could prove beneficial. This standardization would not only minimize errors but also enhance efficiency within both the sub-county and county surveillance systems.

Despite the limitations that Kisumu County faces, sub-county surveillance officers ensure that disease surveillance is community-based and can adapt quickly during outbreak investigations. Sub-county surveillance officers establish a positive rapport with clinicians and facility staff through their regular facility visits. Sub-county officers know facilities so well that they can determine if a new clinic has recently been hired because they notice changes in diagnostic trends. The frequent visits of sub-county officers have ensured that they intimately understand the communities they are working with and are able to explain disease surveillance trends. For example, there is a village in Kisumu East that has only 1 facility that is able to test for Malaria, as a result, they have extremely high malaria positivity rates. This facility receives malaria tests from neighboring villages that cater to vulnerable populations, including those in prison. Consequently, it consistently reports a higher number of malaria diagnoses compared to other facilities in the sub-county. An external observer reviewing the reports from this facility might struggle to discern this specific pattern and could make inaccurate assumptions. Another pro to the surveillance being conducted in Kisumu is the rapid response the county has to outbreaks. Sub-county surveillance officers are the 1st line of defense when an outbreak occurs, and they can coordinate responses very quickly because their teams are not very large. Furthermore, their familiarity with the community enables a fast and coordinated response because communities allow the sub-county officers to implement control measures and effectively communicate with the community to reduce further disease spread. The understanding sub-county surveillance officers have of their community ensures they can recognize patterns, determine where vulnerable populations live, and understand cultural factors that impact disease transmission. The accuracy of their surveillance would not be possible if they did not know their community and their needs.

Data Results:

PBIDS

Along with the analysis of how PBIDS is structured, incidence calculations were done to connect what was done out in the field with previous research studies. Diarrhea cases in children under the age of 5 from 2018-2022 living in Kibera and Asembo will be analyzed.

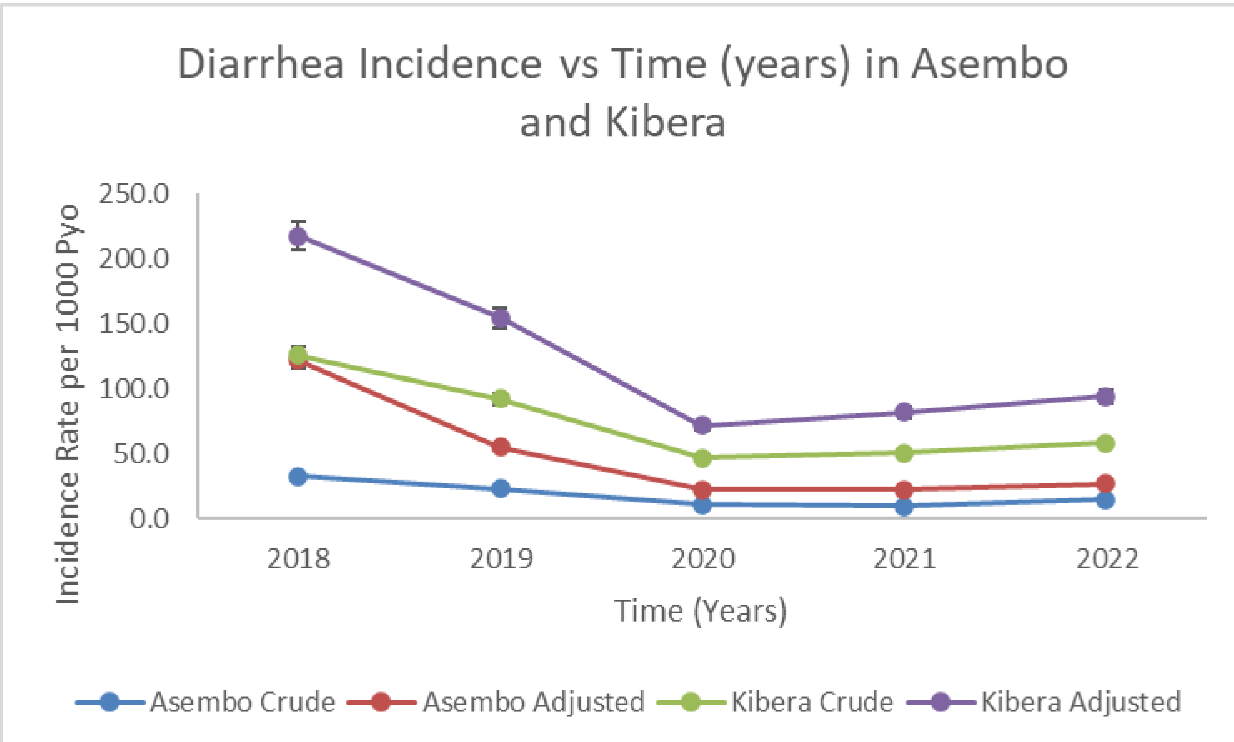

Figure 1: Diarrhea Incidence vs Time (years) in Asembo and Kibera

In Asembo, in the year categories 2018, 2019, 2020, 2021, and 2022, the percentage of all clinic visits for diarrhea to Lwak were 27.2%, 42.2%, 50.0%, 42.9%, and 55.7%, respectively. Incidence rates both crude and adjusted decreased over time until a slight rise occurred in 2021.

In Kibera, in the same year categories, the percentage of all clinic visits for diarrhea at the Tabitha clinic was 57.9%, 59.6%, 65.6%, 62.3%, and 62.0%, respectively. Incidence rates for both crude and adjusted decreased over time until they began to increase again in 2021.

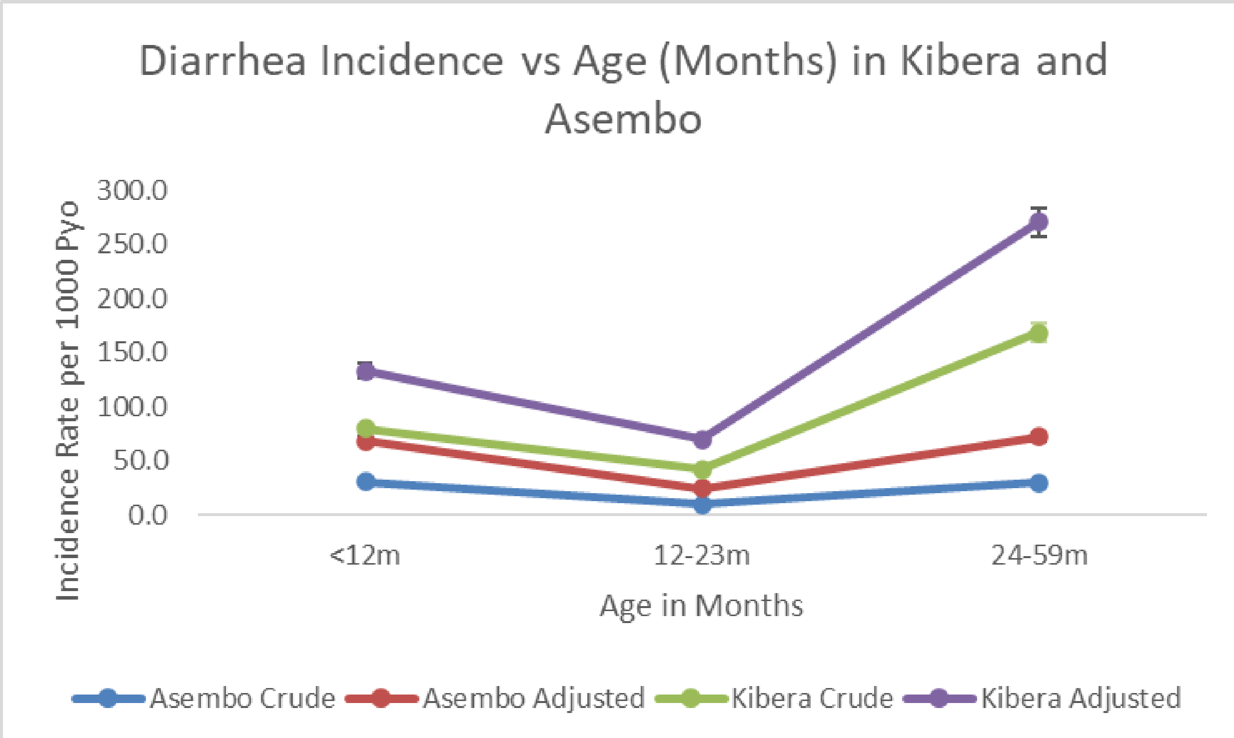

Figure 2: Diarrhea Incidence vs Time (months) in Asembo and Kibera

In Asembo, the age categories were <1 year, 12–23 months, and 24–59 months. Of these ages, the percentage of all clinic visits for diarrhea to Lwak was 44.7%, 42.2%, and 42.2% respectively. The ages <12 and 24-59 months had higher crude rates of 31 and 30 compared to 12-23 months which had a rate of 10 per 1000 Pyo. Additionally, the ages <12 and 24-59 months had a higher adjusted incidence rate of diarrhea at 69 and 72, respectively, and 12-23 months had a rate of 25 cases per 1000 Pyo.

In Kibera, the same age categories were used. Of these ages, the percentage of all clinic visits to Tabitha Clinic was 59.9%, 60.2%, and 62.3%. The ages <12 and 24-59 months had the highest crude and adjusted incidence rates. Crude incidence was 80 and 168 cases for <12 and 24-59 months while 12-23 months had a crude incidence rate of 42 cases per 1000 Pyo. Adjusted incidence rates indicated that 133 and 270 were predicted in children <12 months and 24-59 months respectively, while 12-23 months had an adjusted rate of 70 cases per 1000 Pyo.

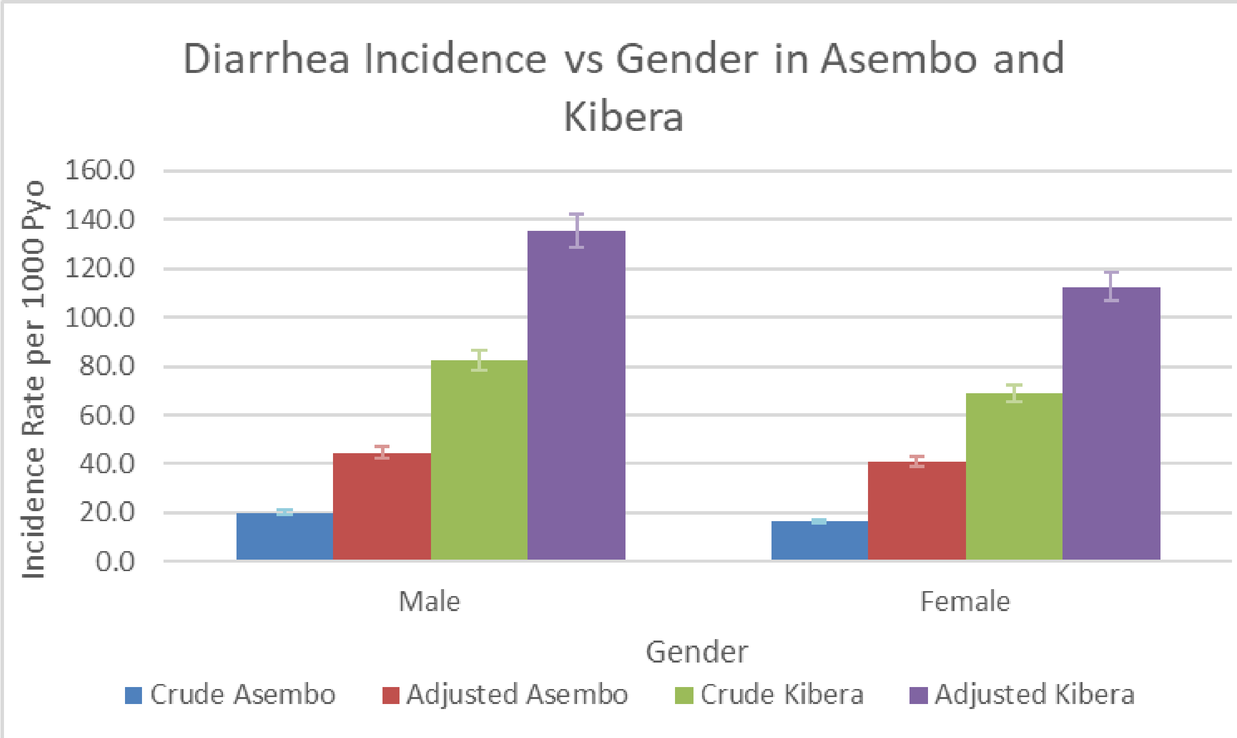

Figure 3: Diarrhea Incidence vs Gender in Asembo and Kibera

In Asembo, when comparing Males and Females under the age of 5, the percentage of clinic visits to Lwak for diarrhea were 45.4% and 39.9, respectively. Males were more likely to present with Diarrhea at Lwak as there was a crude rate of 20 cases compared to 16 for females. In the adjusted rate there were also more cases of male diarrhea than females as it was estimated that there were 45 male diarrhea cases compared to 41 in females.

In Kibera, the percentage of Males and Females under the age of five who visited Tabitha Clinic were 60.9% and 60.8%, respectively. Like in Asembo, males were more likely to present with diarrhea at Tabith having a crude and adjusted rate of 82 and 135. While females had a crude and adjusted incidence rate estimated at 69 and 113 per 1000 Pyo.

Data Analysis and Discussion:

<u>PBIDS</u>

Figure 1 indicates that there has been a decrease in diarrhea incidence over time. The lowest period of adjusted incidence in Asembo and Kibera occurred in 2020, closely followed by 2021. This period happens to coincide with the COVID-19 pandemic. During this period there are multiple reasons the incidence appears to be decreasing: lack of people visiting facilities, improved hygiene practices, reduced movement, fewer social gatherings, not as many interviews, etc. What is especially prominent is the decrease in Lwak Health Center visits during 2021. During 2020, 50% of participants living in Asembo were visiting Lwak Health Center, however, during 2021 the visits to Lwak Health Center decreased to 42.9%. A similar, but less severe drop was noticed at Tabitha Clinic. In 2020, 65.6% of participants were visiting Tabitha Clinic, and during 2021 these visits dropped to 62.3%. The height of the COVID pandemic in Kenya was April 2020-October 2020, during this period KEMRI stopped interviewing participants. Additionally, within Asembo and Kibera participants feared visiting health centers because they were treating COVID cases. This could help explain why care-seeking decreased so dramatically from 2019 to 2020. This fear could explain why in 2021 there was a decrease in participants visiting each health center and incidence remained low. However, unlike in Asembo where care-seeking increased in 2022, care-seeking decreased slightly in Kibera from 62.3% to 62%. This slight decrease could be due to lingering fear surrounding getting COVID at the Tabitha Clinic. A reduction of people visiting health centers could have reduced the perceived incidence of diarrhea within each community as it was not being reported. However, in both communities, there was an increase in adjusted and crude incidence rates in 2022. The reason for this increase could be due to increased movement of people after the COVID pandemic ended. While there was an increase in incidence in 2022, the rate is still much lower than it was before the pandemic occurred in 2020. This could indicate that the reason for continued low diarrhea incidence is due to changes in hygiene practices. During COVID handwashing and sanitation were heavily emphasized. It is possible that these hygiene practices are still being implemented in Kibera and Asembo, reducing the incidence of diarrhea.

Additionally, diarrhea cases were broken down by age into three categories <12, 12-23, 23-59 months. Figure 2 indicates that children in the age ranges of <12 and 24-59 months have higher incidences of diarrhea in both Asembo and Kibera. Children less than 12 months could have an increased incidence of diarrhea because they have underdeveloped immune systems making them more susceptible to infections that cause diarrhea. Additionally, they are still exclusively being breastfed so slight changes in breastfeeding patterns or the introduction of other foods or liquids could increase the risk of diarrhea. The increase in diarrhea in children 24-59 months could be due to changes in dietary habits as they are no longer exclusively breastfeeding. Additionally, children in this range are more likely to have reduced hygiene as they have not yet developed proper hygiene practices. Additionally, they are more mobile giving them more access to areas that could increase the risk of diarrhea.

The last analysis was comparing gender-related diarrhea incidence in Asembo and Kibera. Figure 3 indicates that males are more likely to be diagnosed with diarrhea than females. Males have an adjusted incidence rate of 41 and 113 cases per 1000 Pyo compared to females, in Asembo and Kibera respectively. Journals have found that males in low-middle-income countries are more likely to be diagnosed with diarrhea than females. However, the reasons for this are highly contested and some journals argue that gender incidence rates for diarrhea are similar. Scientists like Jarman indicate that factors such as varied environmental exposures or physiologic sex differences could be the cause of increased diarrhea cases in males (Jarman, 2018). While others argue that cultural bias in care-seeking behavior favors boys to be treated over females (Nair, 2010). The data does indicate that males are more likely to be taken to Lwak 45.4% of the time while females were taken only 39.9%. However, in Kibera, the rate of care sought for both genders are nearly identical at 60%. More research about how genders were treated in Asembo needs to be analyzed before any conclusions can be drawn.

Another takeaway from this data is the low rate of care-seeking that occurs at Lwak Health Center. Despite having access to free care at Lwak Health Center, care-seeking ranges from 27.7% to 55.7%. Asembo is in a rural region, which leads to decreased care-seeking at health facilities because health centers are too far away from participants. A PBIDS publication found that the distance from a participant's home to Lwak Hospital was the most common reason ill participants did not seek care there (Bigogo, 2010). This helps to explain why care-seeking is higher at Tabitha Clinic than at Asembo. All participants are within a 1 km radius of Tabitha clinic, making it much easier to visit the facility than in Asembo. There have been efforts to increase care-seeking at Lwak. While these efforts have been effective at increasing health-seeking, there is still room for improvement.

Furthermore, Kibera tends to have higher incidence rates for diarrhea than Asembo. This could be due to the high population density and worsened sanitation that occurs in Kibera. Kibera has a population density of 77,000 persons per km^2 while Asembo has a population density of 325 persons per km^2. This results in people interacting much more frequently with each other, increasing the rate illness is spread. Additionally, most regions in Kibera do not have access to clean sanitized water as there is frequent contamination. This is because most of the drinking water is pumped in by tubes that lie on the ground, resulting in drinking water interacting with groundwater and wastewater. Also, most toilets in Kibera are pit latrines and during the rainy season, they tend to overflow and further contaminate drinking water and contaminate other surfaces that children will frequently interact with. While many in Asembo also use pit latrines, they tend to be located away from drinking water sources and are not contaminated as easily.

Conclusion:

While there are limitations to the methods used in surveillance in Kenya, their surveillance methods are highly effective because they rely on community-based approaches. Surveillance is not possible without the consent and understanding of communities. While communities in Kenya lack access to a lot of necessary resources, they can collect accurate and reliable surveillance data because they understand how their communities function and the health challenges they face. Working intimately with communities creates trust being researchers and the participants. By harnessing the trust of the community, community members can be involved in health decisions and actions. This allows for community-based solutions to be implemented which have been proven to be more effective, increasing the accuracy and reliability of data. Furthermore, this can lead to generational changes in health trends and practices which benefits both parties.

<u>Lessons Learned</u>

- How an operation like PBIDS is organized and how each sections works together
- How to request data and analyze it
    - What a feasible amount of data is to request and analyze in a designated time frame
- Differences between rural and urban facilities
- How home surveys are run: what questions are asked, who is asked, and what data is collected for
- How research is conducted at KEMRI
    - COVID sequencing
    - Pathogen detection based on base plating

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Appendix

Appendix 1: PBIDS Case Definitions

Case	Definition
Acute diarrhea	Three or more loose than normal stools in a 24-hour period

Severe acute respiratory illness (SARI)	In children < 5 years of age:
	- Cough OR difficulty breathing with acute onset (<2 weeks) AND at least one of the following:
	  - Chest indrawing
	  - Stridor in a calm child
	  - Oxygen saturation <90%
	  - Unable to breastfeed or drink
	  - Vomits everything
	  - Convulsions
	  - Lethargy
	  - Unconsciousness
	  - Admitted or referred for admission
	In adults and children => 5 years of age
	- Cough OR difficulty in breathing OR chest pain with acute onset (<2 weeks) AND at least one of the following:
	  - Fever ≥ 38.0 °C
	  - Oxygen Saturation < 90%
	  - Admitted or referred for admission

Acute respiratory illness (ARI)	Cough OR difficulty in breathing OR sore throat OR Coryza with acute onset (<2 weeks)
Acute febrile illness (AFI)	Persons with temperature ≥ 38.0°C (axillary)

Appendix 2: IRB Action Form

SIT SCHOOL FOR INTERNATIONAL TRAINING
STUDY ABROAD

Human Subjects Review SARB/IRB ACTION FORM

Name of Applicant
Marissa Duffy

ISP/Internship Title:
Surveillance Systems in Kenya: Methods and Effectiveness

Date Submitted: 21st October 2023

Program: KER

Type of review:

Exempt ☐
Expedited ☒
Full ☐

Institution: World Learning Inc.
IRB organization number: IORG0004408
IRB registration number: IRB00005219
Expires: 27 September 2024

SARB members (print names):
Jeremiah Ongwara (Chairman)
Lucy Kageha
Millicent Oloo
Dr. Steve Wandiga (Secretary)

SARB REVIEW BOARD ACTION:

____Approved as submitted ☒
____ Revise and resubmit
____Revisions approved
____ Disapproved

SARB Chair Signature:

Date: 24th October, 2023

SARB Committee Feedback:

Form below for IRB Vermont use only:
Research requiring full IRB review.

ACTION TAKEN:
__ approved as submitted __ approved pending submission or revisions__ disapproved

_________________________________ _________________
IRB Chairperson's Signature Date

OMB date: 2.28.22

<u>Appendix 3:</u> Fieldwork Authorization

REPUBLIC OF KENYA
COUNTY GOVERNMENT OF KISUMU

Telegrams: "PRO (MED)"
Tel: 254-057-2020105
Fax: 254-057-2023176
E-mail: kisumucdh@gmail.com

Director of Public Health, Preventive/
Promotion and Environmental Health
P.O. Box 721 – 40100,
Kisumu.

DEPARTMENT OF MEDICAL SERVICES, PUBLIC HEALTH & SANITATION

Our Ref: GN 133 VOL. XIV/(328)

Date: 4th September, 2023

School for International Training
Milimani – Adala Otuko Road,
P.O Box 7286-40100,
Kisumu.

RE: PERMISSION FOR ATTACHMENT AND TERM PAPER FIELD WORK WITHIN KISUMU COUNTY AND ITS ENVIRONS

The following students are hereby authorized to conduct their attachments and/or term paper field work within the County Government of Kisumu, its health facilities, surrounding communities and in liaison with organizations/institutions that match with their interest areas.

Name	Passport No.	Country	University
Anna Katherine Borasky	590341830	USA	George Washington University
Anna Suzette Cohen	675550723	USA	Scripps College
Cassidy Micah Holmer Orange	682739088	USA	Denison University
Claire Morgan Barlass	A17441429	USA	Bates College
Hannah Marie Povroznik	A06458587	USA	West Virginia Wesleyan College
Lillian Amble Kihanya	A14760251	USA	Pomona College
Marissa Elena Duffy	6451954040	USA	Hamilton College
Shelby Rose Oraskovich	671767914	USA	Tulane University

Any assistance you accord them in the process of conducting their field work will go a long way in promoting intercultural learning that is running from 26th August until 8th December 2023.

We thank you in advance and look forward to a positive response in hosting each student within your space.

Yours sincerely,

COUNTY DIRECTOR OF HEALTH KISUMU

Fredrick O. Oluoch, MPH, HSC, OGW
Director - Public Health & Sanitation
Kisumu County

From the office of Director of Public Health & Sanitation

Appendix 4: SIT Daily Host Site Log

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name: Marissa Duffy

Organization: Lwak hospital

Department: ↓

Date: 11/07

Check in Time: 9:30 am **Check Out Time:** 3pm **Total Number of Hours:** 5 hr 30 min

KEMRI 4-5pm 1 hr } 6 hr 30 min

LIST SKILLS LEARNT:

1. Structure of facility + understanding for how patients flow through the facility. What each room use patients when treatment/referral occurs
   1. cough 2. vitals 3. Health history/symptoms 4. Doctor 5. phlebotomist/specimen collector 6. lab
2. Basic understanding for how individuals are enrolled into PBIDS + the benefits they receive while at facility (free medical care, used to receive free transportation, access to vaccines based on illnesses in region)
3. How to determine if a sample has Malaria parasite + which parasites those are
4. PBIDS is used to determine disease Burden, cause of disease, + possible preventive methods (vaccines, water treatment)
   - preventive services
   - impact of interventions

- Given tour of entire facility + met most individuals in each department
- Fishermen are main cause of HIV in the region
- Referrals go to Bondo → Siaya → JOOTRH

Student Signature: MD

Supervisor Signature: [signature] **Date:** 11/07

Academic Director/AD Designee Signature: [signature] **Date:** 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING
SCHOOL FOR INTERNATIONAL TRAINING
P.O. Box 7286 - 40100
Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KCRH

Department: Surveillance

Date: 11/8/2023

Check in Time: 9 am

Check Out Time: 12pm

Total Number of Hours: 3

LIST SKILLS LEARNT:

How to do Active surveillance →

1. How to examine data books & check for polio (AFP)/measles. Look for runny nose & fever or rashes + fever. This indicates it could be measles/polio that went unaccounted for. Also if multiple ≤15 have these symptoms in the same area at the same time this could indicate an outbreak.
2. Learned what materials some facilities are missing. Kowino is missing Salmonella reagent & is unlikely to get it in the future due to misunderstanding of funds b/tw gov & dispensary funding rules
3. Kowino is struggling to get mothers to come in for cervical exams & many opt out. It is believed that this is due to lack of mental preparedness when they come into the facility. The community could try having CHP's refer mothers/prepare them mentally for cervical exams. , educate further
4.

- 0 cases of AFP or Measles

Student Signature:

[signature]

Date: 1/1/08

Supervisor Signature:

[signature]

Date: 1/12/23

Academic Director/AD Designee Signature: [signature]

Note that you are required to complete one sheet for each day.

WORLD LEARNING SCHOOL FOR INTERNATIONAL TRAINING
P.O. Box 7286 - 40100
Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KCHD

Department: Surveillance - Phillip

Date: 9/11/23

Check in Time: 830 am

Check Out Time: 11:00 am

Total Number of Hours: 2.5

LIST SKILLS LEARNT:

1. I learned what county surveillance officers do/their roles in disease management
2. How to read and understand MOH 503 + 505, what each paper is for, how it is filled out, and how paper is transported for reporting facilities/testing sites
3. How world Rabies day was planned, the communication btw diff organizations (critical analysis), (Health), Phillips pics/opinions on how to reduce rabies, why Siaya has such a high rabies incidence, & how rabies is being treated in ppl (drugs/vaccines) & dogs/vaccines
4. 2 common health indicators: polio & measles & how the county tracks them. Active surveillance + collecting wash water samples

Student Signature:

Supervisor Signature:

Date: 11/4

Academic Director/AD Designee Signature:

Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING SCHOOL FOR INTERNATIONAL TRAINING P.O. Box 7286 - 40100 Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI / Lwak

Department: PBIDS

Date: 9/11/23 + 6/11/23 + 10/11/23

Check in Time: 6/11/23 = 1.5hrs

Check Out Time: 9/11/23 = 3 hrs

Total Number of Hours: 4.5hrs

LIST SKILLS LEARNT:

1. How to critically analyze a procedure & note down questions for future conversations
2. wrote & organized a lit review of multiple journals, protocols, & books
3.
4.

Student Signature:

Date: 11/10

Supervisor Signature:

Date: 1/12/23

Academic Director/AD Designee Signature:

Note that you are required to complete one sheet for each day

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS

Date: 11/10/23

Check in Time: 9:00am   Check Out Time: 3:00pm   Total Number of Hours: 6hrs

LIST SKILLS LEARNT:

1. who to contact when in need of data analysis, lab information, HDSS questions
2. A Basic understanding of GIS & how it is used for PBIDS to conduct data & determine linkages
3. How enrollment, clinic, & Field surveillance are run. What questions are asked, how ppl are identified (village, compound, House, HH), how data is collected (digital)
4. Why Asembo was choosen as a surveillance site. High disease burden endemic to malaria, High HIV burden, very poor region

Student Signature:

Supervisor Signature: Date: 11/10

Academic Director/AD Designee Signature: Date: 1/12/23

Note that you are required to complete one sheet for each day.

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: Traditional Healer

Department:

Date: 11/13/23

Check in Time: 12pm

Check Out Time: 1:30

Total Number of Hours: 1.5hrs

LIST SKILLS LEARNT:

1. How to give a message to reduce stomach, back, & groin pain due to pregnancy
2. How a traditional healer interacts w/ patients & how they work in tandem to the hospital
   - issues telling patients about gender @ hospital but traditional healer tells
   - Try to ensure individuals disclose HIV status (counseling, [illegible])
3. - issues hospitals have w/ dealing w/ complicated pregnancies because majority of staff are residents. Traditional birth attendants are trained better to deal w/ complicated births
4.

Student Signature:

MR

Supervisor Signature:

Date:

Academic Director/AD Designee Signature:

Date:

[signature]

1/12/23

Note that you are required to complete one sheet for each day

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS & Lwak

Date: 11/14/23

Check in Time: 8:40am

Check Out Time: 4:30pm

Total Number of Hours: 8hrs

LIST SKILLS LEARNT:

1. How data is collected at Lwak. How patients flow through Lwak & the questions they are asked at all points along the route
2. How HDSS & PCS interact. HDSS gives every individual an ID # & adds people to PBIDS. PCS uses ID # to flow through Lwak
3. what each color in PCS indicates
   Yellow = enrolled but not active
   Green = active
   Red = dead
4. What PCS is able to show for patients & what pharmacists, clinicians, clerks, & labs is able to input
   - shows patient history, unique ID/visit #, type of payment, drugs req → only shows drugs that are in stock

Student Signature:

Supervisor Signature:

Date: 11/14

Academic Director/AD Designee Signature:

Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING
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Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PEHD

Date: 11/15/23

Check in Time: 8.40am

Check Out Time: 4:00

Total Number of Hours: 7 hrs 20min

LIST SKILLS LEARNT:

1. The general outline for how incidence is calculated / Crude ARI
   -HDSS is used as an adjustment factor
2. How household + facility data is used in tandem to create the incidence calculation
3. WIS is not always accurate to human movements because it uses aerial projection
4. -The vaccine (risk vaccine) is no longer in use (lack of donor funding due to Kenya being a middle income country)
   - The goal to implement a new Typhoid Vaccine for those who are most vulnerable (6-15 kibera / informal settlements)

Student Signature:

Supervisor Signature:

Date:

11/15

Academic Director/AD Designee Signature:

Date:

1/12/23

Note that you are required to complete one sheet for each day.

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS field office

Date: 11/16/23

Check in Time: 7:00am

Check Out Time: 4:45

Total Number of Hours: 9 hrs 45min

LIST SKILLS LEARNT:

1. How compounds are organized + labeled.
   - labeled on each door of each
2. How to run through HDSS / PBIDS survey
   - what a social group is vs a compound
   - How in vs/out migration works
3. Each visit is diff, how to adapt to each visit because each are unique
   ↳Adapt
4.

- biked to compounds

Student Signature:

Supervisor Signature:

Date: 11/16/23

Academic Director/AD Designee Signature:

Date: 1/12/23

Note that you are required to complete one sheet for each day.

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SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: lab & PBIDS

Date: 11/20/2023

Check in Time: 9:40 Check Out Time: 2:40 Total Number of Hours: 5hrs

LIST SKILLS LEARNT:

1. How baseline plating works to help identify what tests to run & what species of bacteria is present & reduce costs
   - chocolate, blood, & Mac (Blood)
   - 4 others for (Fecal)
2. How to make Mac Media
   - Got to go into BSL3 lab
3. Main SSA lab focus when receiving samples' integrity to regulate storage containers (only ice packs & cooler) no other mechanisms
4.

Student Signature: [signature]

Supervisor Signature: [signature] Date: 11/20/23

Academic Director/AD Designee Signature: [signature] Date: 1/12/23

Note that you are required to complete one sheet for each day.

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name: Marissa

Organization: KEMRI

Department: PBIR

Date: 21/11/23

Check in Time: 8:40 am   Check Out Time: 2:40pm   Total Number of Hours: 6 hrs

LIST SKILLS LEARNT:

1. How data is purged if there is an error & how it is cleaned. Either go back into the field or review data & determine descrepances by hand
2. Data is linked together during/after errors are fixed
3. lab primarily uses barcodes for identification while clinic uses visit ID/ HDSS ID
4.

Student Signature:

Supervisor Signature: Date: 21/11/23

Academic Director/AD Designee Signature: 1/12/23   Date:

Note that you are required to complete one sheet for each day.

WORLD LEARNING SCHOOL FOR INTERNATIONAL TRAINING P.O. Box 7286 - 40100 Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS/Lab

Date: 11/22/23

Check in Time: 7:40 Check Out Time: 3:50 Total Number of Hours: 8 hrs 10 min

LIST SKILLS LEARNT:

1. Steps for COVID Sequencing Protocol (1st 1/2)
2. How to accurately determine what type of data to analyze (the frame, available data, cleaned data, etc)
   • How incidence calculations should be used (Theoretically can calculate incidence but need to do it w/ data which will be arguably harder)
3.
4.

Student Signature:

Supervisor Signature: Date: 11/22/23

Academic Director/AD Designee Signature: Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING SCHOOL FOR INTERNATIONAL TRAINING P.O. Box 7286 - 40100 Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS

Date: 11/23

Check in Time: 8:50

Check Out Time: 2:30

Total Number of Hours: 5 ½ hrs

LIST SKILLS LEARNT:

1. How to analyze charts & graph
2. How to create a graph that compares years, age, & gender to adjusted & crude incidence
3.
4.

Student Signature:

Supervisor Signature:

Date: 11/23/23

Academic Director/AD Designee Signature:

Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING
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Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS

Date: 11/24

Check in Time: 8:45am   Check Out Time: 1:00pm   Total Number of Hours: 5 1/4 hrs

LIST SKILLS LEARNT:

1. How to write results & discussion sections for PBIDS data
2. How case scaling data is calculated & added w/o adj incidence calculations
3.
4.

Student Signature: x [signature]

Supervisor Signature: [signature]   Date: 11/24/23

Academic Director/AD Designee Signature: [signature]   Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING
SCHOOL FOR INTERNATIONAL TRAINING
P.O. Box 7286 - 40100
Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS

Date: 11/27

Check in Time: 9:30 am   Check Out Time: 2:30   Total Number of Hours: 5 hrs

LIST SKILLS LEARNT:

1. How to analyze graphs + use literature to back up claims
2. Compared Nyalenda + Asembo incidence rates together
3. Created graphs to compare Nyalenda + Asembo
4.

Student Signature: [signature]

Supervisor Signature: [signature]   Date: 29/11/2023

Academic Director/AD Designee Signature: [signature] 1/12/23   Date:

Note that you are required to complete one sheet for each day.

WORLD LEARNING
SCHOOL FOR INTERNATIONAL
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P.O. Box 7286 - 40100
Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KCRH

Department: Surveillance

Date: 11/24

Check in Time: 6:30 | Check Out Time: 7:30 | Total Number of Hours: 1hr

LIST SKILLS LEARNT:

1. How to collect samples to test for Polio
2. what tests are run on samples (Polio, measles, COVID, bacteria/pathogens)
3.
4.

Student Signature:

Supervisor Signature:

Date: 11/24

Academic Director/AD Designee Signature:

Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING
SCHOOL FOR INTERNATIONAL
TRAINING
P.O. Box 7286 - 40100
Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: PBIDS

Date: 11/29

Check in Time: 9:15am

Check Out Time: 3 p.m

Total Number of Hours: 6hrs

LIST SKILLS LEARNT:

1. How to give a presentation to KEMRI
2. why it is not possible to fit roads or add stuff at Lwak + Asembo (CDC doesn't allow & don't own Lwak Hospital)
3.
4.

Student Signature: X Mark Dff

Supervisor Signature: [signature]

Date: 11/29

Academic Director/AD Designee Signature: [signature]

Date: 1/12/23

Note that you are required to complete one sheet for each day.

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KCRH

Department: Surveillance

Date: Before excursions

Check in Time: Check Out Time: Total Number of Hours: 6hrs

LIST SKILLS LEARNT:

1. How weekly Surveillance Reports are organized, input into KHIS
2. observations Samuel has had about what sort of illnesses/quantity of illnesses are occuring at each facility w/in Kisumu east
3. What a sub-county Surveillance officer does' go into field + do case search, follow up on suspected infectious disease patients, pick samples to test for infectious diseases, + run outbreak investigations
4.

Student Signature:

Supervisor Signature: Date:

Academic Director/AD Designee Signature: Date: 1/12/23

Note that you are required to complete one sheet for each day.

WORLD LEARNING SCHOOL FOR INTERNATIONAL TRAINING P.O. Box 7286 - 40100 Kisumu - Kenya

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: [illegible]

Department: [illegible]

Date: [illegible]

Check in Time: Check Out Time: Total Number of Hours: 5

LIST SKILLS LEARNT:

1. How minor theater in ER works; type of patients seen, injuries that are treated, & procedures run there
2. overview of AI being used to ↑ pregnant mothers antenatal care
3. overview of TB project & how study design gets participants involved in study
4.

Student Signature:

Supervisor Signature: Date:

Academic Director/AD Designee Signature: Date: 1/12/23

Note that you are required to complete one sheet for each day.

SCHOOL FOR INTERNATIONAL TRAINING DAILY HOST SITE LOG SHEET

Student Name:

Organization: KEMRI

Department: lab

Date: [illegible]

Check in Time: Check Out Time: Total Number of Hours: 15

LIST SKILLS LEARNT:

1. What tests each lab runs & where samples came from (PBIDS, KEMRI, Kisumu County, Siaya County, CHAMPS, etc)
2. Various research project occuring at KEMRI (TB surveillance, MDR TB, COVID-19 screening, HIV screening/viral load tests)
3.
4.

Student Signature:

Supervisor Signature: Date:

Academic Director/AD Designee Signature: Date: 1/12/23

Note that you are required to complete one sheet for each day.