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Enhancing Disease Outbreak Response Through Surveillance: A Case Study Of Siaya County, Kenya

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Abstract
The growing threat of disease outbreaks has emphasized the need for effective outbreak response planning. Outbreak response refers to the collective measures aimed at reducing both case numbers and fatality rates. In Kenya, outbreak response efforts have largely been reactive rather than proactive. Counties, as the frontline in detecting disease outbreaks, often lack the necessary resources and preparedness to manage them effectively. Despite its critical role, planning for disease outbreak response has not been given sufficient attention, with limited resources allocated to surveillance systems. This study sought to address this gap by investigating the role of surveillance in disease outbreak response within the health sector in Siaya County, Kenya. The research was grounded in systems theory and control theory. Descriptive survey was adopted. The target population comprised 544 healthcare workers from the Directorate of Medical Services and the Public Health Department in Alego Usonga Sub-County, Siaya County. A sample size of 55, representing 10% of the population, was selected. Data was collected through questionnaires and document analysis, and both descriptive statistics and regression analysis were employed. The findings revealed that effective disease surveillance significantly contributed to timely responses to outbreaks. This underscores the need for government investment in robust surveillance policies and programmes to facilitate coordinated planning by both county and national health systems.
Keywords: *Disease outbreak, surveillance, response*

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I. Introduction

Throughout history, pandemics have had significant impacts, including population loss, societal disruption, and influence on war outcomes. Notable outbreaks include the Athenian Plague (430 BC), Black Death (1334), Spanish Flu (1918), HIV/AIDS (1980s), Ebola (2014), and the recent COVID-19 pandemic, reported in December 2019 and declared a global health emergency in January 2020. A disease outbreak refers to the occurrence of cases exceeding normal expectations, often caused by infections transmitted through human, animal, or environmental contact, or exposure to chemicals or radioactive materials. In some cases, the cause remains unidentified despite investigations (Ashley et al., 2022). The health sector plays a key role in responding to disease outbreaks by implementing measures to prevent the rapid spread of diseases and minimize infections. Effective surveillance is essential for early detection, treatment and containment of outbreaks. This involves allocating adequate funds for preparedness and emergency response activities (Liu et al., 2022). Successful pandemic containment requires objective, efficient and resource-conscious strategies in the surveillance, ensuring minimal effort is used to achieve maximum impact without resource misuse.

It is evident that effective disease surveillance can help in reducing the number of cases through a practical disease outbreak response plan (Meierkord et al., 2024; Li et al., 2024). When the systems for recognizing and responding to disease outbreaks act too slowly, the result is unnecessary delay, greater disease spread, additional people affected, and more lives lost. This can pose serious economic damages especially to poor households. Nonetheless, surveillance systems can be active or passive in nature each with differing effects on disease outbreak responses in terms of efficiency, speed and outcomes when containment efforts. In one hand, passive surveillance depends on routine reporting resulting into delayed identification of outbreaks resulting into increased spread, higher mortality and economic burden (Amanda et al., 2024). On the other hand, active surveillance strengthens continuous and timely detection, reduced spread and economic protection (Kang et al, 2024). However, integration of both active and passive approaches provides a robust surveillance system for greater preparedness and response capabilities. (Sasie et al, 2024). Nonetheless, timely and accurate data from multiple surveillance channel increases chances of effective mitigation of the effects of outbreaks of diseases on both public health and economy. It implies that efficient surveillance system is the one that combines both active

and passive approaches while ensuring timely detection, accurate data collection and effective containment measures are put into place.

In Kenya, outbreaks such as dengue fever, Rift Valley fever, measles, cholera and malaria have also occurred. In response, the country has established a range of surveillance systems to ensure early detection and mitigation of future incidences. These include but not limited to: Integrated Disease Surveillance and Response (IDSR), Kenya Health Information System (KHIS), National Influenza Surveillance Program among others. However, the response efforts often face significant delays and costs hindering timely detection and effective management of outbreaks. For instance, the Northern Kenya experienced measles outbreak in the year 2022 whereby gaps were identified in the vaccination coverage and low public awareness affect disease prevention efforts. In the year 2020, there was an outbreak of Dengue fever in Mombasa County whereby it overwhelmed the healthcare facilities (Gateri et al., 2024). Late response was attributed to delayed relay and sharing of data leading to insufficient vector control measures. Against the background, this study explored the role of surveillance in disease outbreak response within the health sector in Siaya County, Kenya.

II. Statement Of The Problem

Siaya County is one of the counties in Kenya that is most affected by preventable and treatable diseases. According to the County's Annual Development Plan 2016, the major causes of morbidity in the county are: Malaria (54%) respiratory tract infections (15%) and diarrheal diseases (4%). With these 3 preventable illnesses being the main causes of childhood morbidity in the county. The current child mortality rates for the county (NNMR 39/1000 live births, IMR, 111/1000 live births, U5MR 159/1000 live births) are among the highest in the country. Majority of these deaths are due to preventable and treatable illnesses thus highlighting the urgency of setting up planning systems for effective disease outbreak response. In the financial year 2018/2019, the health department in Siaya County was allocated Kshs 376 million which was 5.3% of the total budget. The allocation was to cater for preventive care which focuses on avoiding diseases, early detection of health issues and maintaining overall health (County Government of Siaya, 2018). Despite the efforts, Siaya County is still facing significant gaps in response to disease outbreak response especially the preventable and treatable illnesses. For instance, in the year 2023, Siaya County experienced outbreaks of Rift Valley fever. The Siaya County is also an active hotspot for cholera and malaria (International Federation of Red Cross, 2024). Another health surveillance report by Hallowell et al. (2022) indicates a total number of children's 8,696 (3.9%) children died of preventable diseases between 2003 and 2023. The arising question is why does Siaya County continue to experience high morbidity and mortality from preventable diseases despite the established outbreak response systems.

Literature builds evidence to support that flexible and participatory approaches, timely detection and reporting of disease outbreaks is crucial for immediate and effective response mechanisms (Giancotti et al., 2024; Adegoke et al., 2024). However, the studies by Giancotti et al. (2024) and Adegoke et al. (2024) were contextually limited in their geographical settings which lowered confidence for generalizing the findings. Over-reliance on quantitative data weakened the conclusiveness of the research findings. Furthermore, the conceptualization of disease surveillance lacked clarity and depth indicators that intersect social determinants like gender, age and education level thus limiting the ability to develop inclusive and widely generalizable frameworks. Infilling the knowledge gaps, this study used elaborate data collection and analysis approaches in order to build strong evidence for concluding the findings. The concept of disease surveillance was developed considering the varying sociodemographic of respondents. In order to develop evidence for concluding the findings from a wide geographical setting, the study was conducted in Siaya County in Kenya.

III. Literature Review

Empirical Review

Public health surveillance is a systematic and ongoing process of gathering and analyzing heath data, interpreting and sharing with the relevant stakeholders for timely prevention and control of diseases (Clark et al., 2024). In collaboration, Kenya's Ministry of Health views surveillance as a continuous process whereby data is collected, analyzed, interpreted and relayed to monitors of health problems in order to improve and maintain population health. Effective health surveillance system is crucial in determining health problems for appropriate corrective action. By this recognition, the World Health Organization (WHO), in collaboration with other international development partners, leads efforts to prevent and control high-threat infectious hazards by providing resources and implementing strategies tailored to regional and country levels. The role of the Integrated Disease Surveillance Response (IDSR) under the World Health Organization is on the forefront of prevention and control of epidemic prone diseases. Together with other partners, WHO brings resources to counter these high threat infectious hazards. These strategies are scaled to regional and country levels. Examples of such strategies include:

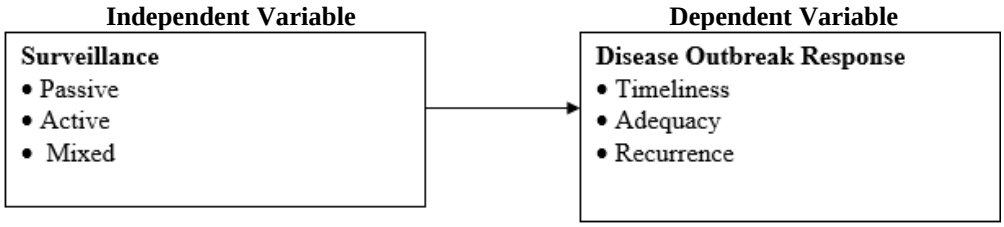
The findings from an empirical study by Sasie et al. (2024) focusing on performance of integrated health surveillance and response systems found that performance differed from one geographical zone to another. This signified the imperative role of contextual characteristics of a study site and populations in shaping effectiveness of a surveillance system. This finding collaborated with that of Lawrence (2024) when doing a systematic evaluating the effectiveness of surveillance of public health during Infectious disease outbreaks that adoption of appropriate surveillance systems enhances effectiveness in controlling the disease incidences. However, both Lawrence (2024 and Sasie et al. (2024) relied on secondary sources of data, documentary and thematic analysis which adversely affected the validity and confidence for generalizing the findings. Also, the findings by the two authors were not supported by any theoretical framework, thus eroding construct validity. In overcoming the methodological and theoretical limitations, this study relied on raw data collected from primary sources and supported the finding using system theory and theory of control.

A related study was carried out by Alhassan and Wills (2024) whereby 1,156 peer- reviewed records were reviewed suing documentary analysis whereby the role of surveillance through data collection, community engagement, screening, testing and treating was found to be very impactful in improving epidemic and disease control. However, the confidence for the conclusion and generalization of the findings was limited over nonuse of primary sources of data and reliance on qualitative methods of data analysis. While conducting a survey that focused on the current capacity for diagnosing priority epidemic-prone diseases at different laboratory levels across African states, Ashenafi et al., (2024) found that effective surveillance and address to health challenges lead to early detection and prevention of future pandemics. But the online survey eroded reliability and validity of the findings because it was very difficult to verify the identity or qualifications of respondents. Instead, this study relied on face-to-face administration of the data collection instruments so as to enhance credulity of the research process.

Theoretical Framework

The study was anchored on systems theory and control theory. System theory emphasizes the importance of coherence interaction of various components within a health surveillance system including but not limited to policy, technology, healthcare workers and the community for sustainable response mechanisms. On the other hand, control provided a strong framework for supporting disease surveillance through monitoring leading to effective mitigation of the spread of diseases. Control theory emphasizes on proactive measures like public campaigns, immunization programs and environmental controls with an aim of reducing the incidence of diseases before they develop into outbreaks.

Conceptual Framework



IV. Methodology

Research Methodology

Descriptive survey was adopted. The target population comprised 544 healthcare workers from the Directorate of Medical Services and the Public Health Department in Alego Usonga Sub-County, Siaya County. A sample size of 55, representing 10% of the population, was selected. Data was collected through questionnaires and document analysis, and both descriptive statistics and regression analysis were employed.

V. Key Findings And Discussions

The objective of the study was to determine the effect of surveillance on disease outbreak response in the health sector of Siaya County. The variable was analyzed using both summary and inferential statistics as presented in tables.

Summary Statistics of Variables for Effect of Surveillance on Disease outbreak

The study had two continuous variables namely age, and experience of health care workers in years and six discrete / qualitative variables. One variable on Likert scale was used to assess the rate of disease outbreak response where the health care workers were asked to record their perception on timeliness for response to disease outbreak. Tables 5.1, 5.2 and 5.3 presents summary statistics of the variables determining the effect of surveillance on disease outbreak response.

Table 5.1: Summary Statistics of Continuous Variables

Variable	Obs	Mean	Standard deviation	Minimum	Maximum
Age (AGE) in years	55	36.36363	8.657824	25	55
Experience (EXP) in years	55	10.13636	6.036505	5	22.5

Source: (Researcher, 2025)

Results from Table 5.1, show that the mean age of the respondents in the sample was 36.36 years implying that majority of the respondents were in the productive age. The youngest respondent was 25 years old while the oldest was 55 years old. The average experience of the health workers was 10.14 years implying that a majority of health care workers in Siaya County had adequate experience in the health sector.

Table 5.2: Summary Statistics for Discrete Variables under surveillance

Variable		Frequency	Percent
Gender (GDR)	Male	30	54.55
	Female	25	45.45
Cadres (CDR)	Community Health Volunteer (CVH)	11	20.00
	Public Health Officer (PHO)	5	9.09
	Nurse	28	50.91
	Clinical Officer	9	16.36
	Medical Officer	2	3.64
Training on Disease Outbreak response (T)	Trained	30	54.55
	Not trained	25	45.45
Undertook Disease Surveillance (SVR)	Undertook	32	58.18
	Did not undertake	23	41.82
Type of Surveillance (TYPSVR)	Passive	17	30.91
	Active	11	20.00
	Passive and Active	4	7.27
	None	23	41.82
Frequency of Surveillance (FSVR)	Monthly	26	47.27
	Quarterly	2	3.64
	Yearly	3	5.45
	Never	24	43.64

Source: (Researcher, 2025)

Table 5.3: Summary Statistics for Variables on Likert Scale

Variable	Obs	Mean	Median	Mode (% representation in mode)
Passive surveillance improves disease outbreak response (PSVR)	55	3.4	3	3 (36.36)

Source: Authors computation from survey data (May, 2020)

From Table 5.3, health workers interviewed were agreeable at 3.4 out 5 that passive surveillance improved timeliness in disease outbreak response.

Regression Results for effect of surveillance on Disease Outbreak

The dependent variable was the rate of timeliness in disease outbreak response (tDR). An ordered probit regression analysis was carried out on equation (3.4) and its marginal effects generated and represented in Table 5.4. Overall, the model explained 8.5 percent of the variations in the probability of the role of surveillance on disease outbreak response in the health sector of Siaya County.

Table 5.4: Ordered Probit Regression Results on Effect of Surveillance on Disease Outbreak response

Variable	Coefficients	Marginal effects (dy/dx)	Z	P > |z|
Age (AGE)	0.0543101 (0.0325881)	-.0084497	-1.53	0.126
Gender (GDR)	-0. 8241337 (0.3608481)	0.1249686*	1.94	0.052
Cadre (CDR)	0.3728205 (0.3486879)	-0.0512795	-1.15	0.252

Experience (EXP)	-0.014138 (0.0448258)	0.0021996	0.32	0.753
Training (T)	0.5002201 (0.3021688)	-0.0809467*	1.66	0.098
Surveillance (SVR)	2.156489 (1.04725)	-0.1260729	-1.83	0.067
Type of surveillance (TYPSVR)	0.3437861 (0.3045007)	-0.0519189	-0.88	0.379
Frequency of surveillance (FSVR)	-0.7021553 (0.6086195)	0.1071082	1.08	0.281
Passive surveillance (PSVR)	0.3775657 (0.1437042)	-0.0570204**	2.10	0.036
Number of obs = 55		LR chi2(9) = 21.53		
Prob> chi^2 = 0.0105		Pseudo R2 = 12.93%		

Source: (Researcher, 2025)

Results presented in table 5.4, show that there were three statistically significant coefficients in the tDR regression equation. The results indicate a negative relationship between passive surveillance and the timeliness to disease outbreak response. Undertaking passive surveillance decreased the time of responding to disease outbreak by 5.70 percentage points while decrease in passive surveillance would increase disease outbreak response time by 5.70 percent. The coefficient was significant at five percent level. This shows that shows that passive surveillance was important in improving the timeliness of disease outbreak response which is measured in short, the duration of response is once an alert have been issued. Training health care workers had a negative relationship with timeliness on disease outbreak response. Undertaking training on surveillance decreased the time of responding to disease outbreaks by 8.09 percent while reducing training increased the likelihood of responding to disease outbreaks by 8.09 percentage points. Training was significant at 10 percent in the timeliness of disease outbreak response. Gender of the health care workers had a negative relationship with timeliness in the disease outbreak response. Being of male gender decreased the time on the disease outbreak response by 12.5 percentage points while being of female gender increased the response time by 12.5 percent. The variable was significant at 10 percent confidence level.

VI. Conclusion And Recommendations

Regression results on the role of surveillance in the disease outbreak response in the health sector of Siaya County indicate that gender, training and passive surveillance influenced timeliness in responding to disease outbreaks. The study established that disease surveillance which is either passive or active are both important in responding to disease outbreaks. However, undertaking passive surveillance was noted to be more important in improving the timeliness of disease outbreak response.

Based on the findings that surveillance has significant influence on disease responsiveness, it is thus of importance for the Government and partners to train health workers, involve them in disease outbreak surveillance and invest in important medical equipment, facilities and other supplies in order to increase the efficiency of disease response.

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