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Leptospirosis Diagnostic Capacity in Public Health Facilities within Nairobi County, Kenya

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Abstract

The presence of biotic and abiotic reservoirs is a possible indicator of leptospirosis occurrence in Nairobi County, which has a large proportion of informal settlements. Despite these epidemiological risk factors, little or no attention is accorded to leptospirosis. The study assessed the degree of leptospirosis diagnostic capacity in public health facilities within Nairobi County, Kenya. A descriptive cross-sectional study involving 133 clinicians and 15 laboratory personnel across 15 public health facilities was conducted between August and December 2019. The perception of zoonotic management was high as 95% (126) had a strong score while 5% (7) had a weak score. Healthcare facility level ($\chi 2$ (3) = 14.09, $p < 0.05$), professional designation ($\chi 2$ (1) = 4.26, $p < 0.05$) had a significant association with suspecting zoonosis. The length of service as a clinician was a significant predictor of suspecting zoonosis, Wald = 11.11, $p < 0.05$. Inter-agency collaboration was low as 89% (119) reported a lack of sharing zoonosis information, and only 8% (10) indicated that there was information sharing. The clinical suspicion index was low, 3.8% of the participants suspected the disease in practice, and 2.3% would consider leptospirosis in the differential diagnosis of FUO. All 15 public health facilities lacked leptospirosis laboratory diagnostic capacity. The probable diagnosis of leptospirosis is low due to a low clinical suspicion index and lack of awareness. There is a lack of laboratory diagnostic capacity. Sensitisation of clinicians and laboratory personnel is critical in increasing the diagnostic capacity of leptospirosis.

Keywords: *Leptospirosis, zoonosis, leptospira, one health (OH), public health, neglected tropical disease, re-emerging infectious disease, clinical diagnostic capacity, laboratory diagnostic capacity, clinical suspicion index.*

Introduction

Leptospirosis is a spirochaetal zoonosis affecting vulnerable populations such as slum dwellers and rural subsistence farmers. It occurs in diverse epidemiological settings. It is a life-threatening disease since it can cause pulmonary haemorrhage syndrome [1]. The global estimate of the disease is 1.03 million cases and 58,900 deaths annually. The adult male within the age bracket of 20-49 years constitutes the largest proportion of the disease burden (48% cases and 42% deaths) [2]. East Sub-Saharan Africa is among the regions believed to be having high disease morbidity and mortality [3]. It has been estimated that

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resource-poor countries like Kenya may constitute a significant disease burden. The burden of leptospirosis tends to be underappreciated in resource-poor countries [4]. The informal settlement is infested by many rodents, which are the primary host of *leptospira*. Leptospirosis may be a problem in slum dwellings due to poor hygiene the presence of biotic and abiotic reservoirs. Rodents are common in slums where they contaminate the environment with the pathogen, thereby increasing the transmission of the disease.

Zoonotic infectious diseases are of great public health concern. [5] showed that 75% of newly emerging infectious diseases (IEDs) are zoonosis resulting from various ecologic, climatic, anthropogenic, socio-economic, and genetic factors. Predicting and preventing zoonotic EIDS is difficult due to these interrelated driving forces. Despite the realisation of several milestones in recent years that include clinical diagnostic methods, improved environmental and medical surveillance, and medical practices, zoonotic EIDs remain to be a significant problem, particularly in less developed regions [6]. Endemic zoonoses are often undiagnosed in humans and mistaken for febrile illnesses like malaria. Endemic zoonoses constitute an enormous disease burden, specifically within the tropics. These diseases affect the health and wellbeing of human beings directly through human disease and indirectly by influencing livelihoods and food security due to losses in livestock production [7]. Endemic zoonoses are poorly understood and rarely recognized despite having multiple impacts on public health. A vicious cycle of ill-health is sustained through widespread mismanagement of these diseases. They remain to be invisible primarily due to low diagnostic capacity.

Several factors hinder the diagnosis of zoonotic diseases like leptospirosis. These diseases have non-specific disease syndrome posing a considerable challenge to both human and animal clinicians [8]. Endemic zoonoses have symptoms that are difficult to identify or differentiate clinically. They share similar symptoms with a wide range of infectious diseases that commonly occur in the tropics [7]. As a result, their burden is mostly underappreciated. The awareness of clinicians and policymakers on endemic zoonoses remains limited, thereby presenting a considerable challenge to diagnosis.

The common non-specific symptoms associated with most endemic zoonoses in humans include headache, fatigue, fever, and muscle or joint pain [9]. These symptoms also commonly occur in febrile illnesses like typhoid fever and malaria, which are more likely to be considered by clinicians [10]. Over-diagnosis of diseases such as malaria is common due to several social influences that include the training context, the pressure to meet the expectation of patients, and the influence of peers [11]. The over-diagnosis of non-zoonotic diseases contributes to the relative underdiagnoses of many zoonoses.

The challenge of non-specific symptoms of zoonoses in humans also applies to animal infection. Unlike their medical colleague, animal health clinicians tend to have fewer observable data to inform diagnosis since the level of disease recognition and reporting is lower than in humans. Although abortion is the most recognizable sign of infection in animals, there is a lack of data on the incidence of livestock abortion. Livestock-dependent settings also suffer from a lack of other productivity measures [6]. The application of one health approach can be of great value in the tropics since zoonoses that affect people also result in abortion in livestock [6].

The challenge physicians face in diagnosing zoonotic causes of human infection is further worsened by the lack of laboratory diagnostic capacity [12]. There is limited capacity to perform reliable diagnostic tests. Few laboratories in resource-poor countries can conduct direct pathogen isolation, blood

culture, or molecular diagnostic assay [13]. Culture and isolation of most zoonotic pathogens pose zoonoses health risks to laboratory personnel. Appropriate containment facilities are required to culture zoonotic pathogens *like Mycobacterium, Brucella zoonoses,* and *Coxiella* [7]. These facilities are few and far apart in most low-income countries.

Addressing re-emerging zoonotic diseases like leptospirosis is pegged on understanding the one health (OH) concept that was coined in 2004 [14]. The prevention and control of leptospirosis remain a significant challenge in developing nations due to a lack of adequate collaboration between players in human and animal health, which is critical as prescribed on the OH concept. The concept is crucial for integrating the human and health disease surveillance and response system [15]. Appropriate integration is essential in controlling zoonotic infections in animal reservoirs enabling early outbreak detection and prevention of deadly epidemics and pandemics [16]. Embracing OH can increase the level of suspicion and awareness of clinicians towards leptospirosis, leading to early detection and decreased morbidity.

Limited laboratory capacity hinders the effective diagnosis of leptospirosis in resource-poor nations. As a result, the provision of care and treatment should be accorded to all patients irrespective of their perceived or confirmed disease status [17]. Since the clinical manifestation of leptospirosis is indistinguishable, leading to confusion and misdiagnosis, applying a clinical decision algorithm for acute pyretic infections may be useful in detecting suspected cases early enough [18]. The execution of OH concept can trigger an appropriate clinical decision algorithm for the effective management of leptospirosis cases. The integration of the human and veterinary sectors is essential in exchanging epidemiological and lab-based surveillance data [19]. The detection of zoonotic infection is hindered by the weak disease surveillance system and inadequate diagnostic capacities [20]. The level of leptospirosis diagnosis is influenced by the collaboration between the human and animal health sector, suspicion and awareness among clinicians, and the capacity of laboratories.

There are limited research studies on leptospirosis, particularly in areas where the prevalence is believed to be high. Leptospirosis is a re-emerging disease due to the growth of informal settlements where both abiotic and biotic factors facilitate its transmission [21]. The few studies on leptospirosis in resource-poor nations such as Kenya have mainly focused on livestock. Although several studies claim that the burden of leptospirosis is underreported in resource-poor countries due to lack of diagnostic capacity, there are no studies that provide data defining the capacity of the public health system to handle zoonotic disease. Several seroprevalence studies have been conducted in various parts of Kenya to investigate the disease in human hosts during an outbreak and the population at-risk [22, 23]. Although leptospirosis may be common in Africa, its burden is underestimated due to a lack of proper surveillance and diagnosis.

Leptospirosis is among the priority zoonotic diseases in Kenya based on the criteria of the One Health Zoonotic Disease Prioritization (OHZDP) tool [24]. The research studies on the prevalence of human leptospirosis in Kenya are minimal. The first human cases were reported in 1977 [25]. Leptospirosis outbreak occurred in the Western part of Kenya (Bungoma district) in 2004, during which there were 141 suspected cases and six deaths [26]. In 2011, cases of leptospirosis were reported in northern Kenya on a study investigating acute febrile illnesses in northern Kenya [23].

Few studies have targeted urban settlement. Most of these studies have focused on the seroprevalence of leptospirosis during outbreaks and among the high-risk groups. The seroprevalence studies have shown the presence of *leptospira* antibodies. A study conducted in

the Kibera slum in 2008 indicated that 18.3% of sampled rodents in the informal settlement had pathogenic *leptospira* [27]. The research further suggests that there is frequent contact between rodents and humans in informal settlements [27]. Therefore, the presence of *leptospira* in rodents could be an indicator of possible human leptospirosis in slum dwellings.

The study focuses on assessing the level of leptospirosis diagnostic capacity in public health facilities within Nairobi County. It provides vital information to assist in explaining the possible reasons behind the lack of leptospirosis burden estimate. Strong diagnostic capacity is crucial in the prevention, diagnosis, and management of leptospirosis. It is critical to establish whether the health system can pick up the disease in a routine setting, particularly in slum dwellings. Leptospirosis may be one of the causes of febrile illness in Nairobi due to the presence of large informal settlements.

Materials and Methods

A descriptive cross-sectional study was conducted between August and December 2019 within 15 public health facilities in Nairobi County. Fifteen laboratory personnel were randomly selected, and consecutive sampling was employed in recruiting 133 clinicians into the study. The study targeted public health facilities that fall within level 3 (health centres) and level 6 (national referral hospitals) in areas with a high proportion of informal settlements. The collection and management of the study data were done using REDCap electronic data capture tool [28]. A pre-tested and structured questionnaire was employed in collecting data. Two types of questionnaires were used. The first questionnaire targeted clinicians, while the second questionnaire targeted laboratory personnel. The questionnaire consisted of several sections. The clinician questionnaire consisted of three sections that include demographic information, the clinical perception of zoonosis management, and the clinical diagnosis of leptospirosis. The laboratory questionnaire consisted of three sections that included demographic information, the diagnosis of leptospirosis, and the laboratory equipment checklist. The study approach included interviewing of the health personnel, direct observation of services provided, and review of secondary data on cases of fever of unknown (FUO) origin from the Kenya Health Information System (KHIS). Descriptive and inferential statistical analysis was used to analyze the collected data using SPSS 25 and Microsoft excel. The descriptive analysis involved frequencies and percentages, while inferential analysis entailed a Chi-Square test and binomial logistic regression at a 95% confidence interval.

Ethical Consideration

The study met all the ethical requirements. The recruitment of participants in the study was voluntary, and no one was coerced. Participation was based on informed, voluntary consent. Privacy and confidentiality were maintained during the collection, storage, and analysis of data. The Principal Investigator (PI) briefed the participants about the study, their roles, and the implication of participation. The participants were granted the right to withdraw their participation even after consenting. No invasive procedures were involved. The questionnaire was coded, and no identifiable information was used to protect the identity of participants. Ethical approval was obtained from the Scientific Ethics Review Unit (SERU) at KEMRI and KNH-UON ethical review committee. The implementation of the study was approved by the JKUAT Board of Postgraduate Study (BPS). The study took place after getting clearance from NACOSTI and the Nairobi County Health Services Department. The PI introduced the heads of the sampled health facilities to the study, and they authorised and facilitated data collection in their respective facilities.

Results

The study sampled 133 clinicians, of which 53.4% were female and 46.6% were male. The distribution of clinicians based on the level of health facility was as follows: health centers (37.6%), county referral hospitals (27.1%), national referral hospitals (24.8%), and sub-county hospitals (10.5%). Clinical officers constituted 64.7% of the participants, while 35.3% were medical officers (Table 1).

The study recruited 15 laboratory personnel, of which 53.3% were female, while 46.7% were male. Laboratory technologists were 80% of the participants, while 20% were laboratory technicians. The study assessed 10 (66.7%) health centres, 2 (13.3%) sub-county hospital, 2 (13.3%) county hospitals, and one national referral hospital (6.7%) (Table 1).

Table 1. Summary of Demographic Characteristics

Characteristics	**No.**	**Percentage (%)**
Clinician - Gender		
Male	62	46.6
Female	71	53.4
Professional Designation		
Medical officer	47	35.5
Clinical officer	86	64.7
Healthcare facility level		
3	50	37.6
4	14	10.5
5	36	27.1
6	33	24.8
Laboratory - Gender		
Male	7	46.7
Female	8	53.3
Professional Designation		
Laboratory technologist	12	80
Laboratory technicians	3	20
Healthcare facility level		
3	10	66.7
4	2	13.3
5	2	13.3
6	1	6.7

The most experienced clinicians who took part in the study had worked for 27 years as a clinician. The mean length of service as a clinician was 8 years and 5 years in Nairobi among the clinicians who took part in the study (Table 2).

Table 2. Length of Service Summary Statistics

		Length of service as a clinician	Length of service as a clinician in Nairobi County
N	Valid	131	130
	Missing	2	3
Mean		8.17	5.31
Median		8.00	5.00
Mode		9	3
Minimum		1	1
Maximum		27	13

Clinical Diagnostic capacity

The participants scored highly on all indicators of clinical perception of zoonotic management except for inter-agency collaboration and information sharing, which seemed to be lacking in the medical practice. The majority of the participants (85%, 113) indicated that they had suspected Zoonosis in clinical practice, and only 15% (20) have never suspected Zoonosis in practice (Table 3). The analysis indicates that 126 participants (95%) recorded a strong clinical perception of zoonosis management while 5% (7) reported a weak score (Fig 1). On the contrary, 119 participants (89%) reported a lack of inter-agency collaboration (Fig 2). Most participants (82.7%) have never received information from animal health practitioners concerning the occurrence of zoonosis in an area (Table 3).

Table 3. Summary of Zoonosis Management Assessment

	Yes	**No**			
	113 (85%)	20 (15%)			
Suspected Zoonosis in clinical practice	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Consider the exposure to animals and their health state	89 (66.9%)	35 (26.3%)	7 (5.3)	2 (1.5)	0 (0%)
Evaluate changes in environment and ecosystem	85 (63.9%)	37 (27.8%)	7 (5.3%)	3 (2.3%)	1 (0.8%)
Consider the occurrence of animal zoonosis	70 (52.6%)	53 (39.8%)	8 (6.0%)	1 (0.8%)	1 (0.8%)
Consider occupational risk	91 (68.4%)	38 (28.6%)	4 (3.0%)		
Existence of a setup for interagency collaboration	5 (3.8%)	5 (3.8%)	4 (3.0%)	31 (23.3%)	88 (66.2%)
	Frequently	**Sometimes**	**Rarely**	**Never**	
Received information on zoonosis occurrence in an area	0 (0%)	17 (5.3%)	16 (12.0%)	110 (82.7%)	

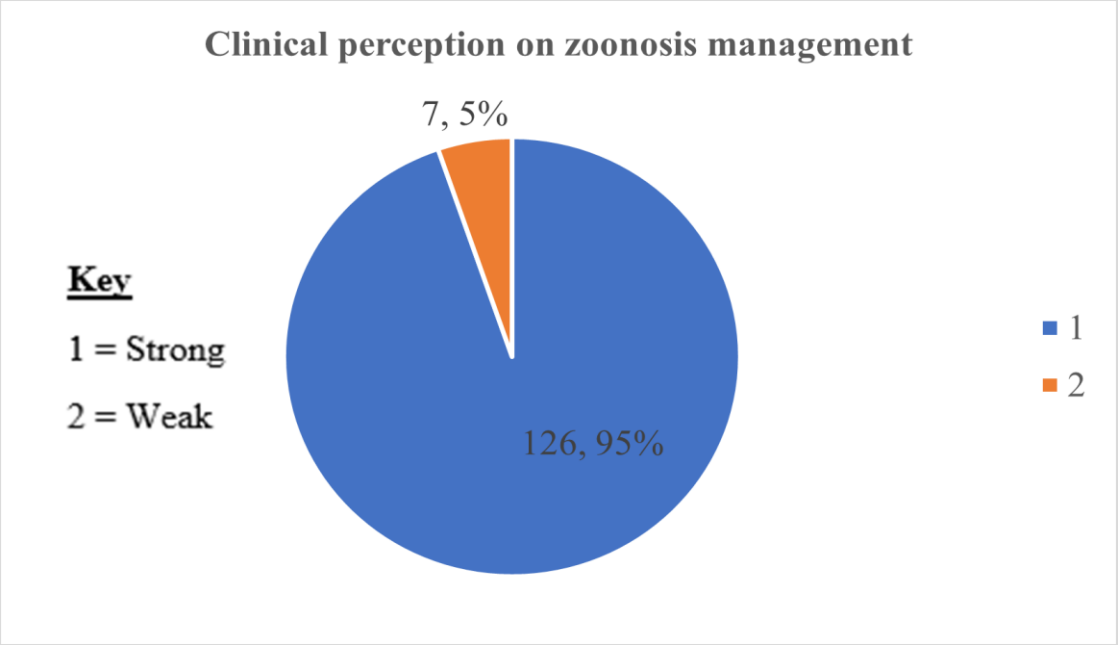

Figure 1. Summary of Clinical Perception on Zoonosis Management

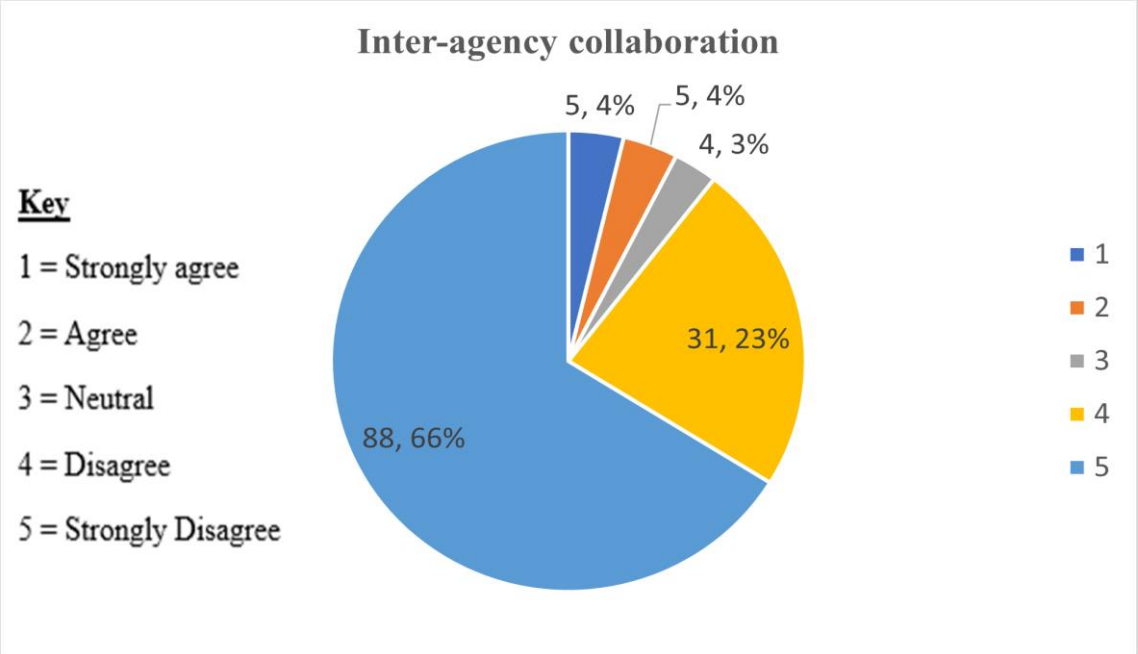

Figure 2. Summary of Inter-agency Collaboration

Fever of unknown (FUO) is common and frequently encountered by clinicians in their practice. Despite the occurrence of FUO, 2.3% (3) of the participants have considered leptospirosis in the differential diagnosis of FUO, and 97% (130) have never considered it. Only 5 (3.8%) of the participants have ever suspected leptospirosis in their clinical practice, while 96.2% (128) have never suspected it (Table 4 and 5). All the health facilities do not have modified Faine's criterion, and none of the participants have ever used the tool in clinical practice (Table 5). One of the cases of leptospirosis that was suspected within the last five years at a level 6 healthcare facility was confirmed positive at a private laboratory.

Table 4. Summary of Clinical Assessment

	Frequently	**Sometimes**	**Rarely**	**Never**
Frequency of fever of unknown origin in practice (FUO)	60 (45.1%)	49 (36.8%)	9 (6.8%)	15 (11.3%)
	Yes	**No**		
Would consider leptospirosis in the differential diagnosis of FUO	3 (2.3%)	130 (97.7%)		
Suspected Leptospirosis in practice	5 (3.8%)	128 (96.2%)		
Facility has Modified Faine's criterion	0 (0%)	133 (100%)		
Ever used Modified Faine's criterion	0 (0%)	133(100%)		

Table 5. Summary of Suspected Leptospirosis in Clinical Practice

Period	**Frequency**	**Percent**
Within the last 5 years	2	1.5
Over 5 years ago	3	2.3
Never	128	96.2
Total	133	100.0

Data from Kenya Health Information System (KHIS) indicate that there are many cases of unspecified fever encountered in public health facilities (Table 6).

Table 6. Summary of cases of unspecified fever in public health facilities within Nairobi County (KHIS)

Year	**Fever <5 years**	**Fever >5 years**
2017	3454	2335
2018	6508	2977
2019	6265	7034

Source: Kenya Health Information system (KHIS), 2019

Association between Demographic Characteristics and Outcome Variables

A chi-square test of association was conducted with the predictor variables as healthcare facility level and professional designation of participants, and the outcome variables as outlined in table 8 below. A significant association was realised between healthcare facility level and suspected zoonosis in clinical practice, $\chi 2$ (3) = 14.09, $p < 0.05$. There was a significant association between healthcare facility level and considering occurrence of animal zoonosis as a sentinel case for the outbreak of human zoonosis, $\chi 2$ (12) = 22.73, $p < 0.05$. The association between professional designation and suspected zoonosis among patients in clinical practice was also found to be significant, $\chi 2$ (1) = 4.26, $p < 0.05$ (Table 7).

Table 7. Summary of Chi-Square Test of Association Results

Healthcare facility level (Predictor variable)			
Outcome/dependent variables	**Pearson Chi-Square**	**df**	**P-value**
Suspected zoonosis in clinical practice	14.086	3	0.003
Consider exposure to animal and their health status	12.164	9	0.204
Evaluates seasonal changes in environment and	10.604	12	0.563

ecosystem			
Information sharing on zoonosis occurrence	4.691	6	0.584
Consider the occurrence of animal zoonosis	22.077	12	0.037
Consider occupational risks	2.774	6	0.837
Setup for inter-agency/profession collaboration	24. 464	12	0.018
Professional designation (Predictor variable)			
Outcome/dependent variables	**Pearson Chi-Square**	**df**	**P-value**
Suspected zoonosis in clinical practice	4.261	1	0.039
Consider exposure to animal and their health status	7.62	3	0.055
Evaluates seasonal changes in environment and ecosystem	3.528	4	0.474
Information sharing on zoonosis occurrence	0.666	2	0.717
Consider the occurrence of animal zoonosis	4.662	4	0.324
Consider occupational risks	2.251	2	0.325
Setup for inter-agency/profession collaboration	10.482	4	0.033

Binomial logistic regression was conducted with the independent variables as health facility level, professional designation, length of services as a clinician, and length of services as a clinician in Nairobi County, and the dependent variable as suspected zoonosis in clinical practice. The model correctly predicted 47.4% of cases where zoonosis was not suspected in clinical practice and 95.5% of cases where zoonosis was suspected, yielding an overall correct prediction rate of 88.5%. Approximately 49.2% of the variability of suspecting zoonosis in clinical practice can be explained by the four predictors. Three of the predictors had no signification relationship with suspecting zoonosis in clinical practice. The association between the length of service as a clinician and suspecting zoonosis in clinical practice was found to be significant, Wald = 11.11, $p < 0.05$, (Table 8).

Table 8. Summary of the Association between Demographic Characteristics and Suspecting Zoonosis in Practice

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	65.816[a]	.278	.492

		No	**Yes**	**Percentage Correct**
Have you ever encountered patients with suspected zoonotic pathogens in your clinical practice?	No	9	10	47.4
	Yes	5	106	95.5
Overall Percentage				88.5

		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Step 1[a]	Healthcare facility level			6.890	3	.075	
	Healthcare facility level (1)	-22.140	6550.592	.000	1	.997	.000
	Healthcare facility level (2)	-22.750	6550.592	.000	1	.997	.000
	Healthcare facility level (3)	-19.033	6550.592	.000	1	.998	.000
	Professional designation (1)	.608	1.208	.254	1	.615	1.837

	Length of service as a clinician.	.671	.201	11.111	1	.001	1.957
	Length of service as a clinician in Nairobi County.	-.353	.204	2.989	1	.084	.702
	Constant	19.506	6550.592	.000	1	.998	296009601.249
a. Variable(s) entered on step 1: Healthcare facility level, Professional designation, Length of service as a clinician., Length of service as a clinician in Nairobi County.							

Laboratory Diagnostic Capacity

All the laboratory respondents from 15 public health facilities indicated that they have never received a request for any type of leptospirosis laboratory test. A dedicated microbiology laboratory was present in 3 (20%) of the facilities. Although all the facilities have a microscope, they are not able to carry out microscopic visualisation of *leptospira*. A non-specific laboratory test can be performed in 2 facilities (20%). These facilities are county referral hospitals (level 5) and the national referral hospital (level 6). Non-specific laboratory tests are critical in the diagnosis of severe/advanced cases of leptospirosis. Most of the laboratory professionals (14, 93.3%) indicated that there is no likelihood that non-specific tests could be performed in relation to the diagnosis of leptospirosis. Non-specific laboratory tests are rarely done in diagnosing severe leptospirosis in level 5 and level 6 health facilities (Table 9).

Although 3 (20%) of the facilities can perform bacterial culture, they lacked the reagents and media required to culture leptospire. Bacterial culture can only be done in the county and national referral health facilities. Rapid diagnostic test (RDT) kits were available in all the facilities. However, all the facilities lacked RDT kits for leptospirosis. Even though the national referral hospital is the only health facility that can perform ELISA, it never had *leptospira*-specific ELISA kits (Table 9).

Table 9. Summary of the Laboratory Diagnosis Capacity Assessment

	Yes	**No**
Dedicated microbiology laboratory section	3 (20%)	12 (80%)
Microscopic visualization	15 (100%)	0 (0%)
Can perform Leptospire microscopy	0 (0%)	15 (100%)
Perform non-specific laboratory tests	3 (20%)	12 (80%)
Can culture bacteria	3 (20%)	12 (80%)
Can culture leptospires	0 (0%)	15 (100%)
Received request for a leptospirosis laboratory test	0 (0%)	15 (100%)
Rapid Diagnostic Test kits	15 (100%)	
Rapid Diagnostic Test Kits Leptospirosis	0 (0%)	15 (100%)
ELISA present	1 (6.7%)	14 (93.3%)
ELISA for leptospirosis	0 (0%)	15 (100%)

Discussion

Most clinicians working in public health facilities within Nairobi County are not able to suspect and diagnose leptospirosis due to lack of awareness and low suspicion index despite the existence of epidemiological risk factors, particularly in the informal settlement. The result is in line with outcomes of other studies [8, 11, 12], which indicated that lack of awareness among clinicians and non-specific clinical features are among the key factors that

contribute to the lack of data on leptospirosis incidence in Africa. Most participants (96.2%) have never suspected leptospirosis, and only 3.8% have suspected the zoonotic condition. Out of the five suspected cases, one turned positive for the disease when the laboratory confirmation was conducted in a private laboratory due to a lack of diagnostic capacity in public health facilities. [29] found out that a large part of private laboratories in Kenya is well equipped with high-quality laboratory equipment and capable of performing different types of microbiological tests.

Although FUO is common in public health facilities, most clinicians do not consider leptospirosis in its differential diagnosis. A small proportion of clinicians (2.3%) considered leptospirosis in the differential diagnosis of FUO. The public health facilities lacked the modified Faine's criterion, nor have clinicians heard or used the leptospirosis diagnostic tool. [30, 31] advocate for the use of modified Faine's criterion and probable diagnosis based on clinical features due to lack of specific laboratory tests, particularly in resource-poor nations.

Human clinicians in the public health sector work in a silo since there is little or no interagency collaboration and information sharing, which is considered a critical aspect in the OH strategy of fighting zoonotic diseases. The analysis indicates that 89.5% of the participants stated that there is no setting for collaboration and information sharing among professionals and agencies dealing with human and animal health affairs. Moreover, 82.7% reported that they have never received information on the occurrence of animal zoonosis in an area from animal health clinicians. [15] advocate for the OH approach in promoting multidisciplinary research efforts to improve understanding of the animal to human transmission of leptospirosis in Africa.

All the 15 laboratories that were assessed have a separate laboratory unit. Dedicated microbiology unit was only found in level 5 (2) and level 6 (1) public health facilities. All the facilities can perform microscopic visualisation but cannot visualise leptospire due to the lack of Fontana stain and Dark Field Microscopy (DFM), which tend to suffer from low sensitivity and specificity.[32] Although the bacteria can be best visualised using DFM, Fontana stain can successfully be used in light microscopy [33]. Even though county level 5 and level 6 health facilities can perform non-specific laboratory tests, it is highly unlikely that they are conducted in relation to the diagnosis of severe leptospirosis. The findings of non-specific tests can be used in the diagnosis of severe leptospirosis [32].

Bacterial culture can only be conducted in level 5 and level 6 facilities, but their laboratories cannot culture leptospires due to lack of special growth media. Modified Ellinghausen McCullough Johnson Harris (EMJH) media is required to culture *leptospira*.[34] Levels 3 and 4 cannot perform microbial culture due to a lack of space and equipment. RDT kits for routine diagnosis exist in the facilities, but not *leptospira* RDT kits. Rapid diagnosis of leptospirosis is essential in accurate antibacterial therapy and evading impending complications [35]. The national referral hospital was the only facility found to have the capacity to perform ELISA, but only for a few specific prioritized diseases of which leptospirosis is not among them. ELISA and MAT are the critical serological laboratory tests for the diagnosis of leptospirosis.[36] The laboratory personnel who took part in the study indicated that they have never received a request for leptospirosis diagnosis in their practice. The laboratories cannot diagnose leptospirosis regardless of the health facility level.

The laboratories of public health facilities are only tailored to conduct a routine diagnosis of diseases that are prioritized by the health system. The analysis indicates that laboratories in public health facilities cannot diagnose leptospirosis. The clinicians never make the

diagnostic requests. As a result, there is no urgency to equip the facilities with diagnostic test kits, reagents, and equipment required to diagnose leptospirosis. Some studies [29, 36] described the quality of microbiology conducted in level 4 and level 5 county laboratories in Kenya as low.

Public health facilities do not have leptospirosis RDTs. [35] established that leptospirosis rapid test kit could offer reasonable positive predictive value (PPV) and negative predictive value (NPV). The kits can be used in detecting specific *Leptospira* IgM antibodies, thereby encouraging the initiation of appropriate therapy without delay. Rapid diagnosis is essential in the provision of proper treatment. According to [6], an adequate surveillance system that includes a strong laboratory network is an essential component in the meaningful prevention and control of zoonotic diseases.

The study established that the leptospirosis diagnostic capacity in public health facilities is low. [37] showed that there is limited capacity for disease detection and surveillance in sub-Saharan Africa (SSA). As a result, the burden of illnesses caused by treatable bacterial infections, their specific etiologies, and the awareness of antibacterial resistance is less well established. Therefore, the ability to mitigate their consequences is significantly limited. [37, 38] posit that there is a lack of diagnostic equipment like culture facilities and susceptibility tests in Kenya. Most of the public health facilities in Kenya have a high diagnostic capacity for diseases in which tremendous international support is available [29]. Even though the public health impact of leptospirosis is highly undocumented in most parts of the world, significant disease burdens are often demonstrated when it is considered in clinical and epidemiological evaluations [7].

Conclusion and Recommendation

Lack of awareness among healthcare workers largely contributes to the low suspicion index and low laboratory diagnostic capacity in public health facilities. Lack of interagency collaboration and information sharing among agencies concerned with the health welfare play a key role in suppressing the ability of the health system to handle zoonotic diseases like leptospirosis adequately. Operationalising the OH approach is a big challenge in low resource settings. The OH paradigm tends to be limited among the scientific, academia, and research community. There is a need to embrace and implement the concept at the grassroots level. The OH approach can only be attained by recognising the interconnectivity that exists between the health of humans, animals, and the biotic and abiotic environment.

Increasing the diagnostic capacity of leptospirosis requires the sensitisation of clinicians to increase their clinical suspicion index. Laboratory personnel and nurses should always be sensitized on leptospirosis diagnosis and management. A concerted effort needs to be taken to implement the OH approach at the grassroots level. Collaboration and information sharing between human health and animal health practitioners is crucial in controlling emerging zoonotic diseases. Early diagnosis can be made possible by ensuring that health facilities have rapid, safe, sensitive, simple, and economical laboratory support. Clinicians need to consider leptospirosis in the differential diagnosis of FUO.

The operationalisation of OH is critical in effectively addressing and reducing the burden of zoonotic infectious diseases. Four key capacity-building needs are crucial in the implementation of OH. They include skilled-personnel capacity building, the development of adequate science-based risk assessment, accredited public health and veterinary laboratories with a shared database, and improved utilisation of the existing natural resources.

Public health facilities need to be equipped with RDT for the initial diagnosis of leptospirosis infection since MAT and ELISA

are out of reach due to resource constraints. RDT assay is critical in ensuring an easy diagnosis. Since it can be treated with antibiotics such as penicillin or doxycycline, accurate and rapid diagnosis provides effective management of the disease. There are commercially available RDT that can be used by hospitals and health centres owing to their accuracy, rapidity, simplicity, and low requirements for skill. MAT and ELISA should be made available for confirmatory tests at referral and research laboratories.

The key limitation of the study is the relatively small sample size that limits its generalizability. Further research involving a larger sample and laboratory tests needs to be conducted in the future.

Conflict of Interest

We have no conflict of interest to declare.

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