



Strengthening the global one health workforce: Veterinarians in CDC-supported field epidemiology training programs

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ABSTRACT

Background: Effective prevention, detection, and response to disease threats at the human-animal-environment interface rely on a multisectoral, One Health workforce. Since 2009, the U.S. Centers for Disease Control and Prevention (CDC) has supported Field Epidemiology Training Programs (FETPs) to train veterinarians and veterinary paraprofessionals (VPPs) alongside their human health counterparts in the principles of epidemiology, disease surveillance, and outbreak investigations. We aim to describe and evaluate characteristics of CDC-supported FETPs enrolling veterinarians/VPPs to understand these programs contribution to the strengthening of the global One Health workforce.

Methods: We surveyed staff from CDC-supported FETPs that enroll veterinarians and VPPs regarding cohort demographics, graduate retention, and veterinary and One Health relevant curriculum inclusion. Descriptive data was analyzed using R Version 3.5.1.

Results: Forty-seven FETPs reported veterinarian/VPP trainees, 68% responded to our questionnaire, and 64% reported veterinary/VPP graduates in 2017. The veterinary/VPP graduates in 2017 made up 12% of cohorts. Programs reported 74% of graduated veterinarians/VPPs retained employment within national ministries of agriculture. Common veterinary and One Health curriculum topics were specimen collection and submission (93%), zoonotic disease (90%) and biosafety practices (83%); least covered included animal/livestock production and health promotion (23%) and transboundary animal diseases (27%). Less than half (41%) of programs reported the curriculum being sufficient for veterinarians/VPPs to perform animal health specific job functions, despite most programs being linked to the ministry of agriculture (75%) and providing veterinary-specific mentorship (63%).

Conclusions: Our results indicate that FETPs provide valuable training opportunities for animal health sector professionals, strengthening the epidemiology capacity within the ministries retaining them. While veterinary/VPP trainees could benefit from the inclusion of animal-specific curricula needed to fulfill their job functions, at present, FETPs continue to serve as multisectoral, competency-based, in-service training important in strengthening the global One Health workforce by jointly training the animal and human health sectors.

1. Introduction

A competent, global public health workforce that consists of professionals from human, animal, and environmental health sectors is

critical in identifying and responding to public health emergencies [1]. Because diseases can spread between humans and animals at the human-animal-ecosystem interface, a workforce that understands these disease dynamics is preferable to a single health sector's prevention and

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response approaches [2].

To support global public health workforce training targets, the U.S. Centers for Disease Control and Prevention (CDC) supports implementation of Field Epidemiology Training Program (FETP) around the world through a mentored, learning-by-doing approach [3,4]. These programs are typically integrated within a country's ministry of health (MoH), allowing trainee activities to align with the priorities, needs, and capacities of the country's public health sector [3]. FETP training levels offered, Frontline, Intermediate, and Advanced, follow three-tiered pyramid model for building capacity at local, district, and national level of a country's health system [3]. Early on, programs only recruited medical doctors from the human health sector [5]. Recruitment has since expanded to include veterinarians, laboratorians, and environmental health professionals. The Thailand FETP became the first program to enroll veterinarians, eventually establishing a separate veterinary-specific FETP, or FETP-V [6]. The Nigeria FETP instructs veterinarians in a separate track within the same program, where veterinary epidemiology-related elements are reflected in course content, field assignments, degrees awarded, and post-training deployments [7]. For most FETPs, multi-disciplinary cohorts are trained together through traditional FETP structures [8–12].

Given the global consensus on the need to build and strengthen a multisectoral workforce to prevent and respond to threats at the human-animal interface [13], evaluation of these training programs is critical to understanding how they can be implemented to meet multisectoral workforce targets. We reviewed CDC-supported FETPs to 1) describe veterinary/veterinary paraprofessional (VPP) graduates and retention of graduates in ministry positions, 2) identify the scope of veterinary and One Health relevant curriculum topics included in these programs, and 3) identify programmatic factors related to multisectoral involvement.

2. Methods

Among the 74 CDC-supported FETPs in 2017, we identified 47 (64%) that had enrolled veterinarians and/or VPPs – an animal health professional authorized by the veterinary statutory body to perform tasks defined by their qualifications and delegated to them under the direction of a veterinarian [14,15]. We invited staff of the 47 FETPs to complete a semi-structured questionnaire covering program and trainee-specific information including: staff and trainee demographics, implementing partners, cohort enrollment and graduation size, training levels and animal health-specific training offered, graduate retention rates, and existing program linkages to government ministries, universities, research institutions. We asked about the in-country presence of a veterinary school and a multisectoral, One Health coordination mechanism (MCM) – a government mechanism that helps address and implement One Health related activities in country [13]. We characterized FETP training level as Frontline, Intermediate, or Advanced; Frontline, a three to four month on-the-job program tailored to the community level, Intermediate, a more intensive nine month in-service training with periodic classroom instruction, and Advanced, the two year training program which prepares experienced professionals for leadership in the national-level of government agencies [16,17]. Program linkages could be in the form of a formal memorandum of understanding (MOU), participating faculty, or mentorship/training opportunities provided by these entities. Graduate retention by host ministry was defined as the number of FETP graduates currently in their positions at the time of the survey.

For veterinary and One Health-relevant training offered, we asked about the inclusion of curricula covering the following topics, 1) animal/livestock production and health promotion, 2) animal/livestock surveillance and investigation, 3) transboundary animal diseases (TADs), 4) zoonotic diseases, 5) One Health, 6) specimen collection and submission, and 7) biosafety practices (i.e., personal protective equipment (PPE) and waste management). We stratified data on curriculum topics by instruction method (lectures, case studies, field studies,

outbreak investigations).

We used Microsoft Excel (2013) to aggregate survey data and analyzed results using R Version 3.5.1 [18]. We calculated measures of central tendency and dispersion for numeric data and measures of frequency and contingency tables for categorical metrics. We used Fisher's exact test to determine significant differences in programmatic characteristics associated with linkages to ministry of agriculture. To validate survey responses, we used routinely collected CDC program monitoring data as a secondary data source. To evaluate content of non-traditional materials, we conducted a secondary review of materials from programs that reported curriculum applicable to the animal health sector according to World Organisation for Animal Health's (OIE) 'Day 1' veterinary competencies and the OIE Competency Guidelines for Veterinary Paraprofessionals [19,20]. CDC determined this project to be a public health program evaluation, therefore institutional review board review was not required as this activity did not constitute human subjects research.

3. Results

The survey was completed by 68% ($n = 32$) of FETPs invited to participate. Among these, 82% were located in either the WHO African (66%) or Americas (16%) Region (Table 1). Resident advisors, senior epidemiologists hired to support program growth and development, were the most frequent (56%) respondents. The training level stratifications, including results for graduation and retention, and the curriculum review was restricted to the 30 programs that reported veterinary/VPP graduates in 2017, corresponding to 20 Frontline, 4 Intermediate, and 16 Advanced level programs. Regardless of program level average time devoted to field placements, as compared to classroom instruction, was greater or equal to 75% of total duration of training time (Table 2).

3.1. Graduation and retention of veterinarians/VPPs in FETPs

Thirty programs (94%) reported veterinary/VPP graduates in 2017 (Fig. 1). One of the participating programs is a Frontline level FETP-V. Up to the time of survey, veterinarians/VPPs represented between 7% and 10% of graduates by cohort, while in 2017 alone, veterinary/VPP graduates contributed to 12% (240/2078) of the total graduates from these programs (Table 2). Twenty-four (75%) programs reported that veterinarian/VPP graduates are guaranteed a permanent position with their host ministry/sector after training completion (Table 1). For the 26 (87%) programs reporting retention data, 91% (528/579) of veterinary/VPP graduates to-date retained their positions with national ministries (not sector specific) (Table 2). Within the MoAg, 74% (391/528) of the veterinarians/VPPs were retained (Table 2). The Intermediate level programs reported the highest retention of veterinary/VPP graduates with MoAg (95%; 18/19), followed by Advanced (81%; 118/146) and Frontline (70%; 255/363) (Table 2).

3.2. Veterinary and One Health relevant curriculum topics offered

Trainees conducted investigations of zoonotic disease outbreaks (Table 2) in 80% of responding programs. Zoonoses accounted for 16% to 44% of all the outbreaks investigated (Table 2). Of the animal health related topics, specimen collection from animals and submission (93%; 28/30), zoonotic diseases (90%; 27/30), and biosafety practices (83% 25/30) (Table 3) were the most common lecture topics. Case studies often covered zoonotic diseases (63%; 19/30), but rarely were animal health topics such as animal/livestock production and health promotion (0/30) or TADs (3%; 1/30) addressed (Table 3). Half of responding programs offered field study opportunities for zoonotic diseases and One Health (53%; 16/30) (Table 3). Outbreak investigations mainly involved the following topics: zoonotic diseases (73%; 22/30), specimen collection and submission (63%; 19/30), and One Health (60%; 18/30) (Table 3).

Table 1
Programmatic Overview of 32 FETPs Enrolling Veterinarians and Veterinary Paraprofessionals (VPPs) in 2017.

Program characteristics	Total programs (N = 32)	
	n	%
Location according to World Health Organization region		
Africa	21	66
Americas	5	16
South-East Asia	1	3
Eastern Mediterranean	1	3
European	3	9
Western Pacific	1	3
In-country implementing partners ^a		
Ministry of health (MoH)	14	44
Ministry of agriculture (MoAg)	7	22
International organizations (FAO: 5; WHO: 3; both: 1)	8	25
University(s)	11	34
FETP networks (e.g. TEPHINET, AFENET)	11	34
Other U.S. Government funded organizations (Defense Threat Reduction Agency: 1, United States Agency for International Development: 1, both: 1)	3	9
Other: including local public health institutes, contracted partners, other national ministries	10	31
Program linkages ^a		
MoH	32	100
MoAg	24	75
Ministry of education (MoE)	9	28
Multisectoral, One Health coordinating mechanism (MCM)	8	25
University	20	63
Research institutions	17	53
Other: military, police, national lab, medical school	5	16
Number of staff per program		
1–2	10	34
3–5	12	41
6–9	4	14
10+	3	10
In-country FETP staff ^b	30	94
Multisectoral, One Health coordinating mechanism (MCM) ^c	22	69
CDC One Health program staff or coordinator ^d	10	31
One Health specific training for trainees ^e	21	66
If no, are willing to incorporate a One Health training	10	100
Veterinary Training		
Country has a veterinary training program or veterinary school	21	66
Country has other veterinary epidemiology training programs (i.e., FAO's ISAVET)	3	9
Veterinarians/VPPs have mentors	30	94
If yes, mentors are veterinarians	20	63
Workforce Development		
MOU with the following ministries/sectors:		
MoAg	9	28
MoH	22	69
MoE	2	6
Veterinary/VPP FETP graduates are guaranteed permanent positions with host ministry/sector	24	75
Believe current FETP curriculum is sufficient for veterinary/VPP to perform job functions within the animal health sector	13	41

FETP: Field Epidemiology Training Program; FAO: Food and Agricultural Organization of the United Nations; WHO: World Health Organization; TEPHINET: Training Programs in Epidemiology and Public Health Interventions Network; AFENET: African Field Epidemiology Network; CDC: U.S. Centers for Disease Control and Prevention; ISVAET: In-service applied veterinary epidemiology training; MOU: Memorandum of Understanding.

^a Multiple response options are possible per program.

^b Staff dedicated to supporting the FETP program that are based in the country.

^c A mechanism that acts to strengthen or develop collaboration, communication, and coordination across the sectors responsible for addressing zoonotic diseases and other One Health challenges at a national or subnational level [13].

^d Designated US CDC staff focused on One Health topics within a CDC Country Office.

^e Training that incorporates aspects of One Health (An approach to address a health threat at the human-animal-environment interface based on collaboration, communication, and coordination across all relevant sectors and

disciplines, with the ultimate goal of achieving optimal health outcomes for both people and animals [13]).

For the 18 programs teaching animal/livestock production and health promotion, animal/livestock surveillance and investigations, and TADs (12/18 programs), we found that animal health instruction was in the form of case studies, field studies, and outbreak investigations, and focused on avian and swine influenza, anthrax, peste des petits ruminants (PPR), foot and mouth disease (FMD), rabies, and brucellosis (not shown). Thirteen (41%) programs reported the curriculum as being sufficient for veterinarians/VPPs to perform their specific job functions within animal health sectors (Table 1).

3.3. Programmatic factors and in-country organizational structures related to multisectoral involvement

Twenty-one (66%) FETP host countries had a national veterinary training program and 22 (69%) reported the presence of an MCM (Table 1). While all programs reported linkages to the MoH, 75% reported linkages to the MoAg, 63% to universities, and 53% to research institutions (Table 1). Thirty (94%) programs reported that the trainees had designated mentors, 20 (63%) of which reported the veterinary/VPP trainees were mentored by veterinarians (Table 1). Between 75% to 100% of program levels surveyed reported cross-training veterinarians/VPPs alongside public health epidemiologists (Table 2). There were no significant differences between the selected programmatic characteristics and linkage to MoAg. Trends suggest a higher frequency of programs with linkages to MoAg also reported host country presence of MCMs, availability of veterinary mentors for veterinary/VPP trainees, and guaranteed permanent positions for veterinarian/VPP graduates with a host ministry or sector (Table 4).

4. Discussion

While we document that in 2017 veterinarians/VPPs represent only 12% of FETP graduates from cohorts in our survey, the high national ministry retention rates and multisectoral training opportunities offered demonstrate that FETPs can play an important role in developing a workforce that understands the human-animal-ecosystem interface dynamics. The International Health Regulations' Joint External Evaluation tool and OIE's tool for assessing Performance of Veterinary Standards include targets and associated competencies for measuring the growth of a veterinary workforce capable of epidemiology and surveillance [1,21,22]. These targets were put in place to ensure that all countries could adequately respond to and control disease outbreaks, including zoonoses and other emergencies that impact animal and human populations.

FETP helps countries attain these global epidemiology workforce targets by requiring that trainees participate in or lead outbreak investigations and spend 75% of their training time in field placements [16]. Reports from Advanced-level veterinary/VPP trainees demonstrate immersive training opportunities including zoonotic and animal disease outbreak investigations [23], sero-prevalence surveys [24,25], and surveillance system evaluations [26]. Our results showed that more than 1 in 4 outbreaks investigated by responding programs were zoonotic in nature. Published reports from Nigeria, Thailand, and Kenya for rabies and avian influenza [6,27–29] document how FETP trainees contribute to the effective prevention and control of zoonoses.

Over half of the veterinary/VPP trainees were mentored by veterinary professionals, possibly enabled by program linkages to MoAgs and existing veterinary training institutions. These mentor-trainee relationships have been important for institutionalizing FETPs [30] and offering career opportunities. The opportunity to cross-train veterinary/VPP trainees with public health epidemiologists has created a foundation for continued collaboration on disease investigations during and after FETP participation. In Ghana, multi-disciplinary teams made up of physician,

Table 2

Descriptive information, outbreak investigations, and graduation rates by FETP level for programs with Veterinary and Veterinary Paraprofessional (VPP) Graduates in 2017.

Program Characteristics	Frontline (N = 20)		Intermediate (N = 4)		Advanced (N = 16)	
	n	%	n	%	n	%
Number of programs that jointly train veterinarians/VPPs with public health epidemiologists	16	89%	4	100%	12	75%
Class Size	Median	IQR	Median	IQR	Median	IQR
Class size	25	24.3–32.6	20	16.5–25.9	15.3	12.8–22.0
Veterinary/VPP class size	2.8	1.0–5.6	2	1.8–2.8	3	1.5–4.0
Training Time	Mean	Range	Mean	Range	Mean	Range
Months in lecture	0.7	0.5–1.0	2.6	1.8–3.0	6	3.0–8.0
Months in field	2.2	0.3–2.5	7.5	4.2–12.0	18	16.0–21.0
Outbreak Investigations	n	%	n	%	n	%
Number of programs that investigated outbreaks in 2017	15	75%	3	75%	16	100%
Number of programs that investigated zoonotic ^a outbreaks	12	80%	2	67%	14	88%
Number of programs that investigated TADs ^b	6	40%	0	0%	3	19%
	Sum	% (N)	Sum	% (N)	Sum	% (N)
Total # of outbreaks investigated in 2017	682	15	51	3	483	16
Total # of zoonotic outbreaks investigated in 2017	297	44% (12)	8	16% (2)	116	24% (14)
Total # of TADs investigated in 2017	88	13% (6)	0	0% (0)	74	15% (3)
Graduation Rates	Sum	% (N)	Sum	% (N)	Sum	% (N)
Total graduates to date	3780	20	279	4	2036	16
Total veterinary/VPP graduates to date	387	10% (20)	19	7% (4)	196	10% (16)
Total graduates in 2017	1680	20	50	3	348	14
Total veterinary/VPP graduates in 2017	186	11% (17)	16	32% (2)	46	13% (8)
Retention	Sum	% (N)	Sum	% (N)	Sum	% (N)
Total veterinary/VPP graduates retained by host ministries out of all veterinary/VPP graduates to date ^c	363	97% (16)	19	100% (4)	146	79% (13)
% Retained by MoH	10	4% (3)	1	5% (1)	20	14% (2)
% Retained by MoAg	255	70% (13)	18	95% (3)	118	81% (11)

FETP: Field Epidemiology Training Program; TAD: Transboundary Animal Disease; MoH: Ministry of health; MoAg: Ministry of agriculture.

^a Infectious diseases that can be spread between animals and humans; can be spread by food, water, fomites, or vectors [13].

^b Transboundary Animal Diseases (TADs) may be defined as those epidemic diseases which are highly contagious or transmissible and have the potential for very rapid spread, irrespective of national borders, causing serious socio-economic and possibly public health consequences [49].

^c Revised denominators for veterinary/VPP retention, uses only the programs with veterinary/VPP graduates that reported retention data: Frontline: 374 (n = 16); Advanced: 186 (n = 13).

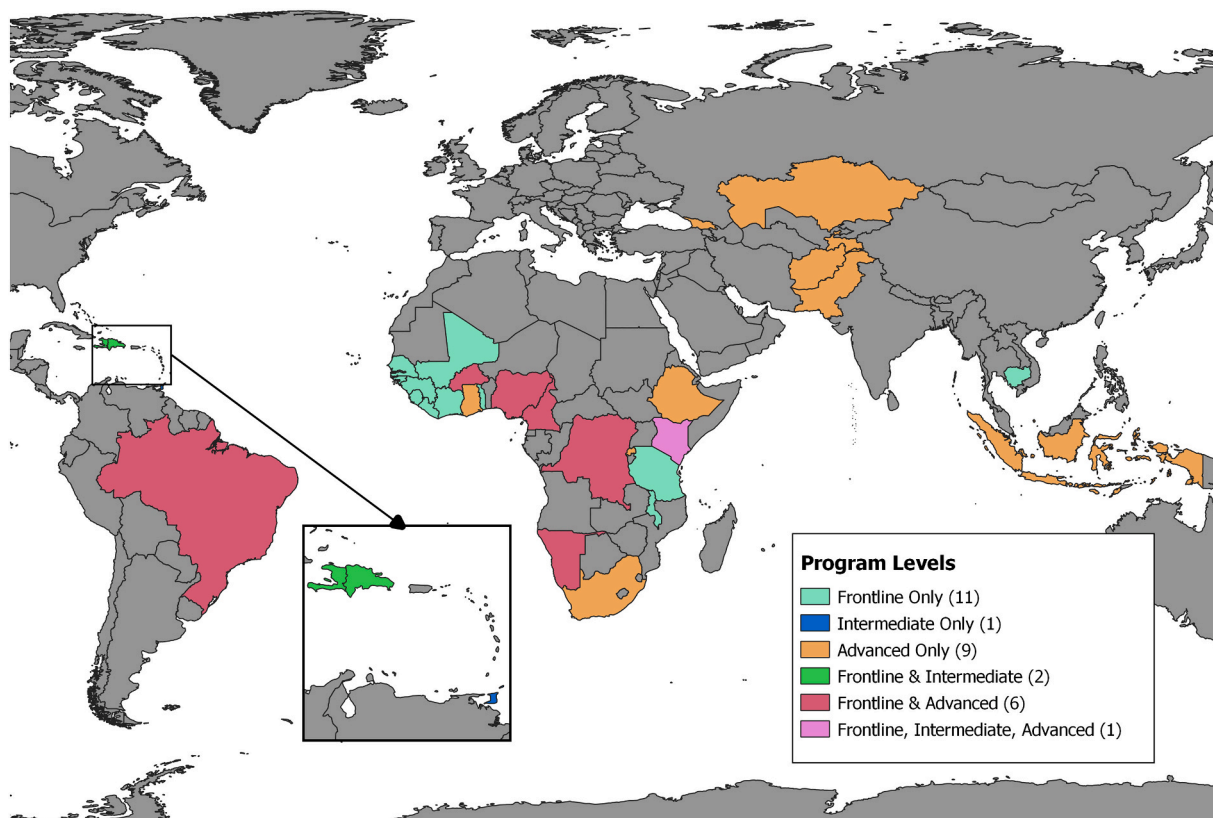


Fig. 1. CDC-Supported FETPs Graduating Veterinarians and Veterinary Paraprofessionals by Country in 2017 (N=30).

Table 3
Veterinary and Animal Health Curriculum Topics by Instruction Method in 2017.

Curriculum	Programs (All Levels) (N = 30)									
	Lecture	Case Studies		Field Studies		Outbreak Investigations		Total Programs Covering Topic ^a		
Animal/Livestock Production and Health Promotion	4	13%	0	0%	3	10%	5	17%	7	23%
Animal/Livestock Surveillance and Investigations	7	23%	3	10%	11	37%	11	37%	13	43%
Transboundary Animal Diseases (TADs)	6	20%	1	3%	6	20%	7	23%	8	27%
Zoonotic Diseases	23	77%	19	63%	16	53%	22	73%	27	90%
One Health	22	73%	13	43%	16	53%	18	60%	24	80%
Specimen Collection and Submission	23	77%	14	47%	15	50%	19	63%	28	93%
Biosafety Practices (Personal Protective Equipment (PPE) and Waste Management)	24	80%	9	30%	12	40%	14	47%	25	83%

^a Totals reflect the total programs covering the topic in at least one of the teaching methods listed.

Table 4
FETP Characteristics Associated with Program Linkages to the Animal Health Sector.

Program Characteristics	Linked with Ministry of Agriculture (N = 32)				Fisher's Exact p-value
	Yes (N = 24)		No (N = 8)		
	n	%	n	%	
Country has a One Health or multisectoral coordinating unit/committee ^a					0.68
Yes	17	71%	5	63%	
No	7	29%	3	37%	
One Health specific training for trainees ^{b,d}					1.00
Yes	16	70%	5	62%	
No	7	30%	3	38%	
Veterinary/VPP trainees have at least one veterinary mentor ^c					0.66
Yes	16	70%	4	57%	
No	7	30%	3	43%	
Programs jointly train veterinarians/VPPs with public health epidemiologists					1.00
Yes	19	79%	6	75%	
No	5	21%	2	25%	
Veterinary/VPP graduates are guaranteed permanent positions with host ministry/sector					0.38
Yes	19	79%	5	63%	
No	5	21%	3	37%	
Any veterinary/VPP graduates retained with MoAg at least two years post-graduation					1.00
Yes	16	67%	5	62%	
No	8	33%	3	38%	

FETP: Field Epidemiology Training Program; VPP: Veterinary Paraprofessionals; MoAg: Ministry of agriculture.

^a A mechanism that acts to strengthen or develop collaboration, communication, and coordination across the sectors responsible for addressing zoonotic diseases and other One Health challenges at a national or subnational level [13].

^b n = 31.

^c n = 30.

^d Training that incorporates aspects of One Health (An approach to address a health threat at the human-animal-environment interface based on collaboration, communication, and coordination across all relevant sectors and disciplines, with the ultimate goal of achieving optimal health outcomes for both people and animals [13]).

veterinarian, and laboratorian FETP trainees investigated and responded to an avian influenza outbreak in 2007, multiple rabies outbreaks between 2009 and 2011, and a monkey-associated Herpes-B encephalitis outbreak in 2011 [31]. In Thailand, the FETP-V established dedicated positions within national agriculture/livestock and health ministries for alumni to collaborate on joint field investigations and surveillance programs for zoonoses [6].

Building on multisectoral relationships established through FETP can further catalyze the formation of MCMs [32–34] and One Health systems

[35]. Enthusiasm around the establishment of national and regional MCMs in recent years follows the commitment to improving global health security by sustaining partnerships needed for effective prevention and response efforts [36–39]. Program linkages with MCMs, which can represent the priorities of ministries of agriculture in tandem with ministries of health may support collaborative training opportunities, thus providing additional career placement options in animal health sectors. Such as in Kenya, where veterinary trainees engaged in joint outbreak investigations through the national MCM. After graduating, these workers obtained or retained their employment in national and sub-national government where they could continue to apply One Health approaches to outbreak investigation and response [40]. Our survey showed that this beneficial connection to MCMs could be strengthened, given that only 8 (36%) of the 22 programs located in a country with an MCM reported a linkage to that MCM.

There is a need to build One Health competencies into human and animal health training programs [41–43]. Core competencies and training modules for One Health have been regionally developed by the South East Asia One Health University Network and the Africa One Health University Network [44,45] that can be adapted to meet this purpose. For animal health specific topics, while many case studies have been developed [46–48], only 41% of programs surveyed reported having curriculum sufficient to support veterinary/VPP job functions. Incorporating material, such as the Food and Agricultural Organization of the United Nations (FAO) technical guidelines and core competencies for field epidemiology training for veterinarians [49] into program curricula, as well as further strengthening program linkages to MoAgs and MCMs could help graduates gain the additional skills needed within the animal health sector.

5. Limitations

Our analysis has limitations that should be considered in interpreting the results. We surveyed only CDC-supported FETPs, a subset of global FETPs. Since CDC-supported FETPs promote the inclusion of multidisciplinary cohorts, the programs included may differ systematically from other FETPs, limiting the generalizability of our findings. We excluded FETPs that did not train veterinarians/VPPs therefore, we cannot evaluate curriculum differences between programs. Due to sample size limitations and the absence of a comparison group, our results are purely descriptive, thus not generalizable to all FETPs. Our results highlight the curricular offerings and inclusion for sampled programs, but our survey did not aim to evaluate effectiveness of competency development for these animal health topics. While our results support FETPs' contribution to the One Health workforce, our analysis focused only on the animal health sector. Thus, we were not able to explore contributions to One Health approaches from other sectors.

6. Conclusions

FETPs serve as a viable method for in-service training of veterinarians/VPPs in core epidemiological concepts, surveillance, and field

investigations for animal health and zoonotic diseases. MoAg linkages and in-country presence of a veterinary institution may facilitate veterinary mentorship and retention of veterinarian/VPP trainees within the MoAg. While FETP curriculum covers One Health and zoonotic disease topics, the presence of and linkage to an MCM could strengthen partnerships between human and animal health sectors. Programs lacking curricula that cover veterinary-specific topics may benefit from incorporating widely available training materials [44,45,49]. International guidance on the prevention, detection, and control of zoonotic diseases recommends that professionals from all relevant sectors be prepared to work together and participate in multisectoral, One Health coordination efforts [13]. The training of animal and human health workers together through FETP offers a promising approach to achieving these important goals.

Authors' contributions

All authors contributed equally to conceptualization, design, analysis, writing and revision of this manuscript.

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Declaration of Competing Interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.onehlt.2022.100382>.

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