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REVIEW ARTICLE

One Health capacity building in sub-Saharan Africa

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Background: Africa of late has been faced with challenges that require a multidisciplinary and multisectoral approach to address them, and academic and non-academic institutions have played a key role in training and conducting research that would promote the One Health approach.

Objectives: The objective of this review was to document networks and organizations conducting One Health training, research, and outreach in Africa, as one of a series of articles around the world.

Methods: Data for this review were collected from organizations through key contacts of the authors and their knowledge of networks they have worked with. Web searches were conducted using One Health, training, and research as key words for work done in Africa.

Results: Africa has major networks involved in One Health training, research, and outreach, with participation of both academic and non-academic institutions. This review highlights an effort in Africa to form networks to conduct multidisciplinary training and research. The main networks include Afrique One, Southern African Centre for Infectious Disease Surveillance (SACIDS), and One Health Central and Eastern Africa (OHCEA).

Conclusions: Both academic and non-academic institutions and organizations have shown an interest to conduct multidisciplinary training and research in Africa for managing challenges that Africa is facing currently, especially the outbreak of infectious diseases.

Keywords: *networks; university; training; research; OHCEA; SACIDS; Afrique One*

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Africa's population is on the rise, especially that of the youth who constitute a substantial percentage of Africa's population (1). With that, there is increase in urbanization and infrastructure development that will continue for the next 20–30 years (2). As populations increase, there is increased demand for animal protein and thus encroachment on forests. By 2050, Africa will see double meat production in order to meet protein needs of the growing population (2). Food and Agriculture Organization (FAO) predicts a need for increased conversion

of forests into farm land. And since more forests are to be turned into agricultural land, there will be an increased demand for water (2). Other challenges such as El Niño might also occur. For instance, in late 2006–2007, in the Horn of Africa, El Niño contributed to the occurrence of Rift Valley Fever (RVF) and also its outbreak in livestock and humans (3). This outbreak led to the realization of the importance of working together of different professionals from veterinary medicine, human medicine, climate forecasting, and ecology, and it led to the development

of a decision support tool for the prevention and control of RVF in the Horn of Africa (4).

The relative risk for emerging infectious disease events from wildlife source has continued to be a challenge in Africa. There are pathogens that are transmitted through the wildlife, livestock, and human interface. Increase in interaction between wildlife, domestic animals, and humans increases the chance of zoonotic disease transmission. It is well known that 60.3% of Emerging Infectious Diseases (EIDs) are zoonotic in nature and that 71.8% of the zoonotic EIDs come from wildlife (5). The challenge of the 21st century is antimicrobial resistance (AMR). The question now is how do we manage AMR, EIDs, and other challenges such as Ebola outbreak that have affected economics of countries such as Liberia, Guinea, and Sierra Leone (6). The WHO definition of health coined in 1946 best expresses what type of approach we need – not just mere absence of disease but complete, social, economic well-being. Benefits of One Health are well discussed by Grace (7) which range from saving on Disability Adjusted Life Years (DALYs), conserving ecosystem health, and saving costs.

One Health is one of the concepts suitable for Africa's current challenges. Closer cooperation between different sectors and disciplines has never been more important than in the past few years. Many authors have indicated the importance of One Health in Africa ranging from advocating for work and research among pastoralist communities in sub-Saharan Africa (8) to tackling zoonotic diseases such as Ebola, to building capacity in health professionals (9), and examining One Health policy, especially, for the control of endemic and neglected zoonotic diseases (10). One good example of One Health at work is with the Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU). In Uganda, a COCTU secretariat was created under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) through a Parliamentary Act of 1992, Chapter 211, to manage control of human and animal Trypanosomiasis (11). The secretariat works closely with different government ministries and intergovernmental organizations such as World Health organization (WHO), African Union-InterAfrican Bureau for Animal Resources (AU-IBAR), and the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC).

Avian influenza outbreak in Africa created one of the first opportunities that led to the initial discussion on the importance of inter-sectoral collaboration amongst different government agencies. For instance, in Nigeria, following the first report of H5NI, a highly pathogenic avian influenza, outbreak in 2006, a National Technical Committee on avian influenza was formed as was the case in other countries such as Uganda, Kenya, and Egypt in Africa (Okello et al. 2014). Agencies in different government

sectors were then brought together to support cross-sector collaboration (12, 13).

In 2010, USAID's Emerging Pandemic Threats Program supported creation of One Health Central and Eastern Africa (OHCEA) (9), a network of academic institutions that started with six countries of Democratic Republic of Congo, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda and now added two more countries, namely Cameroon and Senegal (14). Wellcome Trust, Rockefeller Foundation, Google.org, International Development Research Center (IDRC) in Canada, the European Union, and member states in Africa have been supporting networks such as Afrique One, Training of Health Researchers into Vocational Excellence (THRiVE), Southern African Centre for Infectious Disease Surveillance (SACIDS), and the Consortium for Advanced Research Training in Africa (CARTA) to promote training and research in One Health (9). Most of these networks have been spearheaded by academic institutions because of their long-term commitment to training the future workforce, conducting research, and community outreach. Universities are also composed of different disciplines that might be relatively easier to bring together to champion One Health with an open mind. Universities would play a role regardless of whether the issue is of managing infectious disease before, during, and after a disease outbreak.

Some networks in Africa have created awareness about One Health by bringing together professionals from different disciplines. For instance, SACIDS together with the Tanzania Institute for Medical Research OHCEA held its One Health conference in Arusha, Tanzania, in April 2013 (15). Meanwhile, OHCEA with support from USAID, FAO, and other development partners supported its first One Health conference in Addis Ababa, Ethiopia, in September 2013 and the next in November 2015. All these conferences were opportunities to share researches conducted in different disciplines and create awareness. Professional bodies such as Uganda Veterinary Association (UVA) and Uganda Medical Association (UMA) held their first joint conference in Uganda (16) and more are expected in Africa.

This review article is looking at what major One Health networks and institutions operate in Africa, their memberships, and One Health training and research activities they have. We look at non-academic and academic settings in sub-Saharan Africa. Please note that this list might not be exhaustive and mainly covers networks.

Materials and methods

Information for this review on One Health training and research activities in Africa was gathered through literature search and contributions from members of different organizations provided free of charge. Search was done on what different organizations, within Africa, are doing

on One Health, including training, research, and outreach. Capacity building was taken to be any training conducted within universities, organizations, or government agencies at certificate, diploma, graduate, and post-graduate levels. In addition, information was also got from contacts within different organizations who have either worked on or are involved in One Health or have worked in an organization that promoted One Health in Africa.

A list of key contacts was approached through email and phone calls to provide information on One Health and to document information on their organization's work on One Health. Information was then summarized into Tables 1 and 2. One key limitation of this review article is that not all information was gathered. Authors of this article realize that there are many more organizations, universities, and agencies working on One Health in Africa that have not been included in this article. The authors do appreciate readers who provide more of such information to improve future review articles.

Results and discussion

Academic institutions and networks conducting One Health training and research activities

Academic institutions and networks are, for the purpose of this article, defined as institutions whose sole responsibility is to train undergraduate, graduate, and post-graduate students, and are recognized by government as educational institutions. On the contrary, networks indicated below mainly serve, or are based, at academic institutions even though some of its members may only be conducting research. Detailed information is provided in Tables 1 and 2 for academic training and non-academic institutions, respectively.

Afrique One

Afrique One is a consortium of university and research institutions in East, Central, and West Africa in the countries of Chad, Ivory Coast, Ghana, Tanzania, Uganda, and Senegal that promotes One Health, Ecosystem and Population Health research, training, and awareness (17). The network supports multidisciplinary research and training opportunities to graduate students at Masters and PhD level in zoonotic diseases. Its members include Chad with Institut de Recherche en Elevage pour le Développement, Ghana with Noguchi Memorial Institute of Medical Research (NMIMR), and Tanzania with Muhimbili University of Health and Allied Sciences, Sokoine University of Agriculture, Tanzania Wildlife Research Institute, and the National Medical Institute of Research. In Ivory Coast, its members include University of Nangui Abrogoua and Centre Suisse de Recherches Scientifiques en Côte d'Ivoire (CSRS). Senegal has its regional Vet school – The Inter-States School of Sciences

and Veterinary Medicine of Dakar (EISMV) as a member and finally in Uganda there is Makerere University as its member of the consortium.

One Health Central and Eastern Africa

OHCEA is a network of public health and veterinary medicine institutions created in October 2010 to foster One Health approaches in eight countries of Eastern, Central, and West Africa (14). The main funder so far has been USAID Emerging Pandemic Threats Program and others such as IDRC, Canada; Higher Education for Development; USA Department of Defense; and Defense Threat Reduction Agency (DETRA) through Sandia National Laboratories. The members of OHCEA include University of Buea and Université des Montagnes in Cameroon; Jimma University, Mekelle University, and University of Addis Ababa in Ethiopia; University of Lubumbashi and University of Kinshasa in the Democratic Republic of Congo; University of Nairobi and Moi University in Kenya; University of Rwanda in Rwanda; Muhimbili University of Health and Allied Sciences and Sokoine University of Agriculture (SUA) in Tanzania; Ecole Inter-Etats des Sciences et Médecine Vétérinaires (EISMV) in Senegal; and Makerere University in Uganda. Briefly, the main aim of OHCEA is to foster One Health approaches across the network members, support national agencies to build capacity in surveillance, reporting, and disease outbreak response (14) in partnership with the University of Minnesota and Tufts University.

Most of its activities in the different member institutions are centered on pre-service training in addition to in-service trainings and research. For instance, OHCEA institutions, through support from USAID, have provided funds for multidisciplinary research at graduate level to all member universities to conduct research in zoonotic diseases and other subjects that related to One Health. Some OHCEA institutions such as Makerere University, Mekelle University, SUA, and the University of Nairobi have One Health field attachments whereby multidisciplinary groups of students from nursing, veterinary medicine, public health, agriculture, and public health live and work together in small multidisciplinary teams in the community. The main objectives of the One Health field attachments are to train students to address complex health challenges in the community. This is done through developing One Health teams that are able to conduct holistic community assessment at the human–animal and environment interface, develop community-based interventions, and work closely with communities to evaluate interventions using available resources.

OHCEA institutions have also championed creation of One Health student clubs. Nearly every university within OHCEA has a One Health student club. For instance, the University of Rwanda (18), Moi University (19), Makerere University, and the University of Nairobi (20) have

Table 1. Academic One Health training, research and outreach activities

School	Country	One Health activities
Ecole Inter-Etats des Sciences et Médecine Vétérinaires (EISMV)	Senegal	EISMV is a member of Afrique One and OHCEA. It serves as a regional veterinary school for most Francophone countries in Africa.
Jimma University	Ethiopia	As a member of OHCEA, it has been training students and staff on one Health, and conducting One Health student club debates. Both schools of veterinary medicine and public health are members.
Makerere University	Uganda	It is a member of Afrique One and OHCEA. The headquarters for OHCEA is situated at this institution at the School of Public health. In addition, Makerere University hosts infectious disease institute and RUFORUM that conduct multidisciplinary training and research for graduate students.
Mekelle University	Ethiopia	It is one of the OHCEA institutions that hold multidisciplinary One Health field attachments, e-learning, training of community members on infectious diseases by both college of veterinary medicine and public health.
Moi University	Kenya	Moi University is a member of OHCEA. It currently runs a Field Epidemiology program in collaboration with Kenta Ministry of Health. It also has a vibrant One Health student club that promotes one Health through awareness campaign and social media discussions (such as Twitter and Facebook) and participation in field attachments.
Muhimbili University of Health and Allied Sciences	Tanzania	It is a member of Afrique One, SACIDS, and OHCEA
Sokoine University of Agriculture	Tanzania	It is the headquarters for SACIDs and is also sponsored by PREDICT and OHCEA. It is a member of Afrique One, SACIDS, and OHCEA.
Stellenbosch University	Republic of South Africa	Its medical school is a member of SACIDs.
Universite des Montagnes	Cameroon	Member of OHCEA. It's the only private university member of the OHCEA network promoting student multidisciplinary field attachments and One Health student clubs.
University Nangui Abrogoua	Côte d'Ivoire	It is a member of Afrique One.
University of Addis Ababa	Ethiopia	This university is the newest member of OHCEA admitted into the network in October 2016. It has had collaborations with US universities to conduct One Health Summer Institutes.
University of Buea	Cameroon	The Faculty of Health Sciences and Faculty of Agriculture and Veterinary Sciences are members of OHCEA and they teach health sciences.
University of Kinshasa	DRC	The School of Public Health is a member of OHCEA and participates in OHCEA activities.
University of Lubumbashi	DRC	The Faculty of Veterinary medicine is a founding member of both OHCEA and SACIDS.
University of Nairobi	Kenya	Both the School of Veterinary Medicine and Public Health are members of OHCEA and they have One Health activities.
University of Nairobi	Kenya	University of Nairobi, both Faculty of Veterinary medicine and School of Public health are members of OHCEA. They both collaboratively, together with Moi University, participate in One Health field attachments, One Health student clubs, support for student research.
University of Pretoria	Republic of South Africa	It is member of SACIDs with an institutional One health platform, a partner of One health program at the South Africa Regional Global Disease Detection Center. It is one of the partners for the Ecohealth Alliance that promotes multidisciplinary research.
University of Rwanda	Rwanda	University of Rwanda One Health student club members participate in community awareness on sanitation, Rabies, and have One Health field attachments.
University of Zambia	Zambia	School of Medicine and School of Veterinary Medicine are both members of SACIDs. It has a Masters of One health in analytical epidemiology.

vibrant student clubs who participate in the promotion of One Health within the community and amongst students. They share their activities and communicate amongst themselves using social media such as Twitter, Facebook, and Radio talk shows. They participate in disease

awareness campaigns, disease outbreak response, and community educational campaigns.

OHCEA has also been supporting curriculum reviews for both graduate and undergraduate programs to incorporate One Health approaches and concepts related to

Table 2. Non-academic One Health training, research and outreach activities

School/Organization	Country	One Health activities
Central Veterinary Research Institute	Zambia	Member of SACIDs.
Centre for Environmental Stewardship	Kenya	The Centre of Environmental Stewardship is an NGO that looks at the complex ecosystem and involves communities to manage the environment using different disciplines.
Centre Suisse de Recherches Scientifiques en	Côte d'Ivoire	Member of Afrique One
Directorate of Animal Sciences – Institute of	Mozambique	Member of SACIDs
Agricultural Research of Mozambique – Ministry of Agriculture		
Eduardo Mondlane University	Mozambique	Member of SACIDS
Ifakara Health Research & Development Centre	Tanzania	Member of SACIDs
Institut de Recherche en Elevage pour le	Chad	Member of Afrique One
Development		
Intergrated Control of Neglected Zoonoses	Different countries in Africa	ICONZ works with up to 22 different organizations in Africa and Asia on One Health on zoonotic diseases in a multidisciplinary manner.
National Health Institute – Ministry of Health	Mozambique	Member of SACIDS
National Institute for Biomedical Research	DRC	Member of SACIDS
National Institute for Communicable Diseases of the National Health Laboratory Service	Republic of South Africa	Member of SACIDs
National Institute for Fisheries Inspection (INIP)	Mozambique	Member of SACIDs
National Institute for Nature Conservation (ICCN)	DRC	Member of SACIDs
Noguchi Memorial Institute of Medical Research	Ghana	Member of Afrique One
Tanzania Wildlife Research Institute	Tanzania	Member of Afrique One SACIDs
The Central Veterinary Laboratory	Tanzania	Member of SACIDs
The Central Veterinary Laboratory in Kinshasa	DRC	Member of SACIDS
The National Institute for Medical Research	Tanzania	Member of Afrique One and SACIDs
Tropical Diseases Research Institute	Zambia	Member of SACIDs
International Centre for Insect Physiology and Ecology	Kenya	ICIPE applies One Health approach in research on humans, insects, animals, and environmental health by making use of multidisciplinary teams.
Zoonotic and Emerging Diseases Group	Kenya	They conduct research on zoonotic diseases using One Health approach at the livestock, human, and wildlife interface.
WELCOME TRUST-KEMRI PROJECT	Kenya	Conducts multidisciplinary research on human and animal health.
One Health Resource Centre	Kenya	One Health consultancy and resource center is a voluntary organization based in Kenya whose main objective is disseminating health information and research findings to the general public for improved knowledge both on human and animal health issues.

international health regulations and the performance of veterinary services by the World Organisation for Animal Health (OIE). OHCEA has also been spearheading the development of short courses such as Risk Analysis and One Health Leadership for both in-service and pre-service training.

Regional Universities Forum for Capacity Building in Agriculture

Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) is a consortium of approximately 60 African Universities in 25 countries from Western, Central, Eastern, and Southern Africa (21). Even though it does not typically mention One Health as

its main mission nor its goals and definitions, its *modus operandi* involves multidisciplinary training and research. It provides training programs for students at Masters and PhD level, especially in Agriculture.

Southern African Centre for Infectious Disease Surveillance

In Southern Africa, SACIDS (www.sacids.org) plays a key role in training of graduate and undergraduate students on zoonotic diseases. Unlike OHCEA which is composed of only academic institutions, SACIDS has academic, government agencies, and research institutions in 'southern' Africa as its members (22). These countries are the Democratic Republic of Congo, Mozambique, Republic

of South Africa, Tanzania, and Zambia. In the Democratic Republic of Congo, member institutions include the University of Kinshasa, the University of Lubumbashi, the National Institute for Biomedical Research, the Central Veterinary Laboratory in Kinshasa, and the National Institute for Nature Conservation (ICCN). In Mozambique, it's the Eduardo Mondlane University, the Directorate of Animal Sciences in Ministry of Agriculture, the National Health Institute in the Ministry of Health, and the National Institute of Fisheries Inspection. The Republic of South Africa has the National Institute for Communicable Diseases of the National Health Laboratory Service (NICD/NHLS), the Onderstepoort Veterinary Institute of the Agricultural Research Council (ARC-OVI), the University of Pretoria, and Stellenbosch University. Meanwhile, in Tanzania, they have the same members as that in OHCEA such as SUA and MUHAS. However, SACIDS has government agencies in addition to educational institutions, namely the National Institute for Medical Research (NIMR), Ifakara Health Research and Development Centre in Tanzania, the Central Veterinary Laboratory (CVL), and the Tanzania Wildlife Research Institute (TAWIRI). Meanwhile in Zambia, its members include the University of Zambia, the Central Veterinary Research Institute (CVRI), and Tropical Diseases Research Institute (TDRC). SACIDS has fostered international partnerships with mainly the London International Development Centre, the Royal Veterinary College, the London School of Hygiene and Tropical Medicine, and The Pirbright Institute. Their main funders have so far been Wellcome Trust, the Rockefeller Foundation, Google org, and IDRC in Canada.

SACIDS supports One Health graduate and post-graduate research and training in areas, including short courses and One Health-based graduate courses (23). Their approach is to create a community of practice in research using both One Health and Ecohealth approaches (24, 25).

University of Ibadan

The only known program presently involved in One Health training is the Nigerian Field Epidemiology and Laboratory Training Program (NFELTP). It is a service-oriented training program with three different options or tracks: applied epidemiology, public health laboratory practice, or veterinary epidemiology, which started in 2008 in conjunction with the universities in Nigeria, namely Ahmadu Bello University in Zaria, and the University of Ibadan in Ibadan (26). The University of Ibadan has also been conducting research and training (27) in addition to current initiatives such as developing a One Health Coordinating Centre for West Africa (28) and development of Masters of Science (One Health) degree program and One Health Residency Program. The university is also

working closely with the Veterinary Council of Nigeria to draft a harmonized veterinary curriculum for accredited veterinary schools in Nigeria which includes One Health courses for veterinary students in Nigeria (29).

Non-academic (non-credit activities) trainings and research

Animal and Human Health for the Environment and Development

Animal and Human Health for the Environment and Development (AHEAD) was created at the IUCN Works Parks Congress in South Africa in 2013. Its programs focus on health, conservation, and development challenges within an environmental and socioeconomic context. They act as mechanisms for convening researchers, policy makers, and trainers to discuss how to address challenges at the human–livestock and wildlife interface, including providing updates to different stakeholders on One Health (30).

Biosciences eastern and central Africa – International Livestock Research Institute Hub

The Biosciences eastern and central Africa-International Livestock Research Institute (BecA-ILRI) Hub is a shared agricultural research and biosciences platform with world-class laboratories and facilities (31). The BecA-ILRI Hub brings together more than 40 research institutions, universities, government ministries, regional agencies, and non-government organizations across more than 16 countries in Africa, Australia, Europe, and USA. Funding is from organizations such as Bill and Melinda Gates, Canadian International Development Agency, IDRC – Canada, the Department of International Development (DFID), United States Department of Defense, DETRA, and the Australian Centre for International Agricultural Research (ACIAR). The hub provides opportunities for students, faculty, and researchers for training, research, and mentorship at their research facilities and technology platforms.

At BecA-ILRI, main areas of focus are in line with One Health approach. For instance, the hub supports multi-disciplinary research in food safety, animal health, human health, and environmental and occupational health. Other topics covered extensively by the hub include zoonotic diseases, microbial interaction, genomics, bioinformatics, metagenomics plus other studies that cut across disciplines. They also deal with biosafety and biosecurity trainings in their laboratory facilities in accordance with international guidelines supported by the ILRI Institutional Biosafety Committee (IBC).

Conservation Through Public Health

Conservation Through Public Health (CTPH) is a grassroots NGO and a non-profit organization that promotes

biodiversity conservation by enabling people, wildlife, and livestock to coexist through improving their health and livelihoods in and around Africa's protected areas (32). CTPH has three integrated programs: wildlife health and conservation, community health, and alternative livelihoods. CTPH provides field-based accredited learning opportunities for university students at undergraduate, master, and PhD level to study the model, conduct research, and gain field practical experience in One Health and conservation working at the Gorilla Health and Community Conservation Centre, and with the Veterinary and community Village Health and Conservation Teams (VHCTs). CTPH works closely with Uganda Wildlife Authority, Bwindi Community Hospital – an NGO missionary hospital, Kayonza Government Health Centre III, and Kanungu District Medical and Veterinary Officers.

PREDICT consortium

The PREDICT consortium is composed of researchers working on a USAID Emerging Pandemic Threats Program (EPT) funded project called PREDICT. They work in different countries of Africa and Asia to identify animal reservoirs for viruses, especially in rodents, non-animal human primates, and bats. Institutions involved in this project to promote 'One Health in Action' include the Gorilla Doctors (under the University of California-Davis), Metabiota, Ecohealth Alliance, Wildlife Conservation Society (WCS), and the USA Smithsonian Institute (33).

African Field Epidemiology Network

African Field Epidemiology Network (AFENET) has played a key role in Africa to train on One Health. It was the first network to produce One Health fellows (34). It has hosted several conferences bringing together different disciplines to share their experiences in disease outbreak response (35). With funding from USA Centers for Disease Control and Prevention (CDC), their main role has been to train field epidemiology and laboratory management to prepare member states for infectious disease outbreaks (36).

Government managed zoonotic programs

Some countries in Africa have come up with means to promote multidisciplinary and multi-inter-sectoral collaborations and partnerships. Such initiatives include the Kenya Zoonotic Disease Unit and the Cameroon Zoonoses Program. The Kenya Zoonotic Disease Unit (ZDU) was created to foster collaboration between the Ministry of Health and the Ministry of Agriculture, Livestock and Fisheries using a One Health approach (34). It implements One Health in Kenya and is involved in policy creation, advocacy, communication, and One Health leadership among government officials. With funding from government and donor organizations, they have created zoonotic technical working groups,

created awareness about One Health, and championed training on One Health at different county levels in the country.

In Cameroon, the government created a program to promote One Health. This program is called the National Zoonoses Program for emerging and re-emerging infectious diseases (37) with similar initiatives being promoted in Africa (38). It has membership from seven ministerial departments that help coordinate activities related to One Health such as response to the recent avian influenza outbreak in Cameroon. Similar initiatives are also present in other African countries. Uganda has had a vibrant Ministry of Health that promoted One Health approaches in managing disease outbreak investigation within and outside the country (39) and in November 2016 launched a One Health Platform with two operational levels - a One Health Technical Working Group and a Zoonotic Diseases Coordination Office - that has linkages to relevant government ministry sectors. Such initiatives of working across disciplines and sectors are a trend that is expected to continue in Africa.

Conclusions

In sub-Saharan Africa, One Health has taken root in different academic and non-academic institutions. It is evident that this has been due to the challenges different nations have faced such as the Ebola outbreak in West Africa where professionals from different nations including Uganda participated in (40). Most of the academic and non-academic institutions are under the umbrella of networks. From the review, it can be seen that some institutions belong to more than one network. For instance, Makerere University and SUA belong to both Afrique One and OHCEA. Would this be a way for different institutions to tap into limited funds for training and conducting research in One Health? Some of the institutions are coming up with degree programs that look at One Health. The sustainability of funding for such programs is at stake given the limited pool of funders. In some instances, One Health is more focused on zoonotic diseases. With the growing interest in One Health, focus should move away from just infectious diseases to other issues such as AMR, climate change, environmental degradation, and other topics that will help accomplish the UN Sustainability Development goals.

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References

1. United Nations (2013). World Population Prospects, the 2012 revision; Highlights and advance tables. New York: United Nations.
2. Alexandratos N, Bruinsma J. World agriculture towards 2030/2050: the 2012 revision. ESA Working Paper No. 12–03. Rome: FAO; 2012.
3. Jost CC, Nzietchung S, Kihu S, Bett B, Njogu G, Swai ES, et al. Epidemiological assessment of the Rift Valley fever outbreak in Kenya and Tanzania in 2006 and 2007. *Am J Trop Med Hyg* 2010; 83(Suppl 2): 65–72. doi: <http://dx.doi.org/10.4269/ajtmh.2010.09-0290>
4. Consultative Group for RVF Decision Support. Decision-support tool for prevention and control of Rift Valley fever epizootics in the Greater Horn of Africa. *Am J Trop Med Hyg* 2010; 83(Suppl 2): 75–85. doi: <http://dx.doi.org/10.4269/ajtmh.2010.83s2a03>
5. Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, et al. Global trends in emerging infectious diseases. *Nature* 2008; 451: 990–3. doi: <http://dx.doi.org/10.1038/nature06536>
6. Thomas MR, Smith G, Ferreira FHG, Evans D, Maliszewska M, Cruz M, et al. The economic impact of Ebola on sub-Saharan Africa: updated estimates for 2015. Washington, DC: World Bank Group; 2015. Available from: <http://documents.worldbank.org/curated/en/541991468001792719/The-economic-impact-of-Ebola-on-sub-Saharan-Africa-updated-estimates-for-2015> [cited 26 October 2016].
7. Grace D. The business case for One Health. *Onderstepoort J Vet Res* 2014; 81: E1–6. doi: <http://dx.doi.org/10.4102/ojvr.v81i2.725>
8. Greter H, Jean-Richard V, Crump L, Béchir M, Alfoukh IO, Schelling E, et al. The benefits of ‘One Health’ for pastoralists in Africa’. *Onderstepoort J Vet Res* 2014; 81: E1–3. doi: <http://dx.doi.org/10.4102/ojvr.v82i2.726>
9. Travis DA, Chapman DW, Craft ME, Deen J, Farnham MW, Garcia C, et al. One Health: lessons learned from East Africa. *Microbiol Spectrum* 2014; 2: OH-0017–2012. doi: <http://dx.doi.org/10.1128/microbiolspec.OH-0017-2012>
10. WHO (2013). Integrated control of neglected zoonoses in Africa: adapting the ‘One Health’ concept. Available from: http://whqlibdoc.who.int/hq/2008/WHO_HTML_NTD_NZD_2008.1_eng.pdf [cited 17 September 2013].
11. COCTU. The coordinating office for the control of Trypanosomiasis in Uganda. The Government of Uganda, Ministry of Agriculture, Animal Industry and Fisheries. Available from: <http://coctu.go.ug> [cited 26 October 2016].
12. Okello A, Gibbs EPJ, Vandersmissen A, Welburn SC. One Health and the neglected zoonoses: turning rhetoric into reality. *Vet Rec* 2011; 169: 281–5. doi: <http://dx.doi.org/10.1136/vr.d5378>
13. Chien YJ. How did international agencies perceive the avian influenza problem? The adoption and manufacture of the ‘One World, One Health’ framework. *Sociol Health Illn* 2013; 35: 213–26. doi: <http://dx.doi.org/10.1111/j.1467-9566.2012.01534.x>
14. OHCEA. One Health central and eastern Africa, Makerere University, Kampala, Uganda. Available from: www.ohcea.org [cited 25 October 2016].
15. SACIDS. Changing landscape for health research in Africa. The 27th Annual Joint Scientific conference and 2nd One health Conference in Africa. Available from: <http://www.sacids.org/kms/resources/ABSTRACT-PROGRAM-BOOK-APRIL-2013.pdf> [cited 29 October 2016].
16. Uganda Medical Association – Uganda Veterinary Association. Uganda medical association – Uganda Veterinary Association joint conference. Disease eradication: what will it take? Available from: [http://www.onehealthinitiative.com/publications/Uganda Medical Association-Uganda Veterinary Association Joint Conference February 14 2013.pdf](http://www.onehealthinitiative.com/publications/Uganda%20Medical%20Association-Uganda%20Veterinary%20Association%20Joint%20Conference%20February%2014%202013.pdf) [cited 29 October 2016].
17. Afrique One (2016). African Research Consortium for Ecosystem and Population health. Available from: <http://www.afriqueone.net> [cited 30 October 2016].
18. University of Rwanda. University of Rwanda One Health Students club. Kigali, Rwanda: University of Rwanda. Available from: <https://ohscur.wordpress.com/about-us-2/> [cited 25 October 2016].
19. OHW. Moi University One Health Student Clubs – a One Health feature. University of Minnesota, USAID One Health Workforce Project. Available from: <https://medium.com/one-health-workforce/moi-university-one-health-student-club-571aa35d6bed#6ndz3buxl> [cited 20 October 2016].
20. UON (2016). One Health Club of the University of Nairobi – The One Health outreach and collaborative activities of the club. Nairobi, Kenya: University of Nairobi. Available from: <http://studentorganisations.uonbi.ac.ke/ohsa-uon/about-us/> [cited 26 October 2016].
21. RUFORUM. The Regional Universities Forum for Capacity Building in Agriculture. Available from: <http://www.ruforum.org/our-member-universities> [cited 25 October 2016].
22. SACIDS. Southern African Centre for Infectious Diseases Surveillance-African Centre of Excellence of Infectious Diseases of Humans and Animals in Eastern and Southern Africa. Available from: <http://www.sacids.org/oweb/sacids/home/about~us> [cited 26 October 2016].
23. Rweyemamu MM, Karimuribo ED, Mboera LEG. The changing landscape for health research in Africa: the focus of the Southern African Centre for Infectious Diseases and Surveillance. *Onderstepoort J Vet Res* 2014; 81 Art#799: E1–2. doi: <http://dx.doi.org/10.4102/ojvr.v81i2.799>
24. Rweyemamu MM, Paweska J, Kambarage D, Namuba F. Towards one Africa, One Health: the SACIDS One Health focus on infectious diseases’. *Onderstepoort J Vet Res* 2012; 79: Art. #449 2 pages. doi: <http://dx.doi.org/10.4102/ojvr.v79i2.449>
25. Rweyemamu M, Kambarage D, Karimuribo E, Wambura P, Matee M, Kayembe JM, et al. Development of a One Health national capacity in Africa: the Southern African Centre for Infectious Disease Surveillance (SACIDS) One Health virtual centre model. *Curr Top Microbiol Immunol* 2013; 366: 73–91. doi: http://dx.doi.org/10.1007/82_2012_244
26. Babalobi OO. Experience in implementing the One Health approach implementing One Health with the Nigerian Field Epidemiology Laboratory. One Health: concept to action panel session. International Conference on Emerging Infectious Diseases March 12, 2012 (ICEID 2012) Atlanta, GA, p. 18. Available from: http://www.iceid.org/images/2015/iceid_2012_finalprogram_final.pdf [cited 26 October 2016].
27. Babalobi OO. Moving One Health forward in Nigeria: the significant past, present and future role of University of Ibadan, Ibadan, Nigeria: Stirling-Horden Publishers Limited; 2015, p. 104. ISBN: 978-978-032-557-2.
28. OPI. Office of programs. Ibadan, Nigeria: University of Ibadan. Available from: <http://oip.ui.edu.ng/towards-making-the-university-of-ibadan-a-one-health-coordinating-centre-in-west-africa> [cited 29 October 2016].
29. Babalobi OO. Developing One Health curriculum for Nigerian Veterinary Institutions: tributes to the memory of three One

- Health pioneers in Nigeria. Ibadan, Nigeria: Stirling-Horden Publishers Limited; 2015, p. 108. ISBN: 978-978-032-556-5.
30. AHEAD. Animal and human health for the environment and development. Available from: <http://www.wcs-ahead.org/news/archive.html> [cited 25 October 2016].
 31. BecA. Biosciences eastern and central Africa – International Livestock Research Institute (BecA – ILRI) Hub. Available from: <http://hub.africabiosciences.org> [cited 29 October 2016].
 32. CTPH. Conservation through public health. Available from: <http://ctph.org> [cited 31 October 2016].
 33. PREDICT Consortium (2016). One Health in action. Davis: EcoHealth Alliance, One Health Institute, School of Veterinary Medicine, University of California; 2016.
 34. AFENET. AFENET produces Africa's pioneer One Health fellows. African Field Epidemiology Network (AFENET), Kampala, Uganda. Available from: http://www.afenet.net/new/index.php?option=com_content&view=article&id=149:afenet-produces-africas-pioneer-one-health-fellows&catid=46:old&Itemid=156&lang=pt [cited 31 October 2016].
 35. AFENET. AFENET Projects. African Field Epidemiology Network (AFENET), Kampala, Uganda. Available from: http://afenet.net/new/index.php?option=com_content&view=category&id=40&layout=blog&Itemid=58&lang=en [cited 31 October 2016].
 36. Monday B, Nakacubo-Gitta S, Wasswa P, Namusisi O, Bingi A, Musenero M, et al. Paradigm shift: contribution of field epidemiology training in advancing the 'One Health' approach to strengthen disease surveillance and outbreak investigations in Africa. *Pan Afr Med J* 2011; 10(Suppl 1): 13.
 37. ZDU (2016). Kenya Zoonotic Disease Unit. Kenya: Republic of Kenya. Available from: <http://zdukenya.org/one-health-activities/> [cited 29 October 2016].
 38. USAID. Workshop on the promotion of «One Health» approach in Cameroon. Press release. Available from: https://yaounde.usembassy.gov/pr_09282011.html [cited 31 October 2016].
 39. WHO (2012): The One Health meeting in the African region. Libreville-Gabon: Okoume Palace Hotel. Available from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiow52RuYbQAhWgHsAKHW9KBSgQFgggMAA&url=http%3A%2F%2Fwww.afro.who.int%2Findex.php%3Foption%3Dcom_docman%26task%3Ddoc_download%26gid%3D8958%26Itemid%3D2593&usq=AFQjCNEoq6fI_AMD4_W8W191vYUnifGNNA [cited 31 October 2016].
 40. Mbonye AK, Wamala JF, Nanyunja M, Opio A, Makumbi I, Aceng JR. Ebola viral hemorrhagic disease outbreak in West Africa – lessons from Uganda. *Afr Health Sci* 2014; 14: 495–501.