International Journal of TROPICAL DISEASE & Health

26(3): 1-15, 2017; Article no.IJTDH.35541
ISSN: 2278–1005, NLM ID: 101632866

Ebola Outbreaks Public Health Emergencies in Fragile Conflicts Zones and Displaced Populations in Africa

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Authors' contributions

This work was carried out in collaboration amongst all authors. Author ET conceived the study and designed methodological search strategy and assessment. Author ET performed the review search and wrote the primary draft of the paper. Authors OAO, CFC, IW, JKJ, MF and JYN provided additional country information. Author ET provided extensive revision and update. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2017/35541
Editor(s):
(1) Shankar Srinivasan, Department of Health Informatics, University of Medicine & Dentistry of New Jersey, USA.
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(5) João Roberto Cavalcante Sampaio, State University of Rio de Janeiro, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/21330

Systematic Review Article

Received 18th July 2017
Accepted 22nd September 2017
Published 11th October 2017

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ABSTRACT

Little is documented on conflict and displacement impact on West Africa Ebola Virus disease (EVD) outbreaks. The paper revisits Ebola outbreaks public health emergencies in fragile conflict zones and displaced populations across Africa. Findings showed that the duration of conflict/war events varied one to forty three years. Notably, Darfur war in Sudan and South Sudan lasted between 18-23 years, RD Congo and Guinea incessant political and ethnical or mining conflict instability repeatedly ranging between 2-6 years, Liberia and Sierra Leone 5 and 12 years conflict/war events associated Ebola outbreaks were documented following seven and four years of conflicts from 1989-1996 and 1999-2003 prior to a democracy nation era in Liberia respectively. Worldwide, there have been 28,639 cases of Ebola virus disease and 11,316 deaths as at December, 2016 compared to recent Zika virus outbreaks in Latin America. Ebola outbreak public health emergencies advocacy, community social mobilization and engagement, Ebola awareness, effective and culturally dignified communications, social media and mass media risk communication, community literacy and preparedness, emergency response engagement and participation, access and deployment of digital technology applications (Health map) in surveillance, tracking and monitoring and key traditional burial practice behaviours changes were being translated into positive successes and benefits that geared rapid and effective prevention of further spread and containment activities of West Africa Ebola outbreak. Inter-humanitarian organizations, institutions and other stakeholders including government cooperation and coordinated leadership, commitment and investment were laudable in supporting accountability and transparency in the overall objectives of public health emergency preparedness planning, care management systems in Ebola outbreak centres, public awareness, epidemic early detection and rapid response as well as effective immunization programs implementation to outwit Ebola virus. Sierra Leone conflict lasted from 1991-2002, Guinea recorded frequent relentless instability than Liberia with two major conflict periods from 1989-1996 and 1999-2003. For the first time, we established a statistical significant correlation between duration of war/conflict events and Ebola outbreaks onsets in Africa ($P<0.05$).Unexpectedly; the total fatality rate in Liberia or Sierra Leone only was greater than the previously reported cumulative EVD cases across Africa since 1976. It is crucial to intensify advocacy on conflicts/wars resolutions to disaster risk reduction framework evidence practice implementation of peace building in fostering health and socioeconomic development and growth. Authors call for the urgent need for concerned commitment and engagement of all stakeholders to develop, implement and strengthening local, national, regional and global public health emergencies evidence practice approaches and strategies including national public health disaster emergency situations insurance models and schemes integration is paramount in disaster high risk prone settings and particular in Africa.

Keywords: Public health emergencies; evidence; practice; preparedness; response; conflict; war; displacement; resolution; consequence; Ebola; outbreak; Africa.

1. INTRODUCTION

Given the unprecedented scale and emerging outbreaks public health emergencies with limited absorptive capacity and functional surveillance and early warning systems in most African countries, the West Africa Ebola outbreak in the most affected three countries was declared as public health emergency of international concern (PHEIC) in early 2014. The deadliest disease in history and highly unparalleled dimensions of human contagious through diverse transmission routes dynamics and severe to contain, leading to over almost 28,638 cases affected and more than 11,316 deaths worldwide [1]. The West Africa Ebola outbreaks requires further in-depth in untangling the potential drivers and issues that trigger the unhealthy events and reducing life expectancy with diverse health and socioeconomic consequences in different geospatial affected and non-affected communities in Africa [2]. The WHO declared Ebola outbreak as a public emergency of international concern in West Africa early March 2014 as the number of cases and fatality rate has increased significantly with more than 6,700 children orphans from previous 1,433 deaths due to Ebola outbreaks prior 2014 [1]. The Ebola epidemic has taken a heavy toll on the already limited health workforce including some

humanitarian workers having about 21 to 32 times high risk probability to be infected with Ebola (815 confirmed and probable cases reported) than people in the general population in the three most affected countries (Liberia, Sierra Leone and Guinea) [1,2]. Several risk factors and determinants those contributed to the rapid scaling up West Africa Ebola outbreak public health emergency were attributable to deficiencies in mounting timely and effective national and regional infectious diseases surveillance-response and early warning systems, governments and stakeholders including humanitarian organisations, coordinated logistics and management inappropriateness, weak or lack of capability of health systems to respond to health emergencies and meeting routine community and frontline healthcare needs. In addition to local staff shortages, long working hours, unpredictable and delayed health workers remuneration, community resistance and stigmatization, poor social protection, lack of preparedness capabilities (workforce and infrastructure) to personal protective equipment (PPE), defective infection prevention and control (IPC) and cultural-behaviour practice, and poor mastering of frontline conditions and social-anthropological determinants [1,2,3]. The resulting unsettled conflict resolution and peace agreements consequences such as, human and animal displacement, food insecurity, forest and wildlife incursions, illicit hunting and poaching and complex vicious cycle of poverty could be responsible for the West Africa Ebola eruption and public health consequences and losses [2,4]. Africa has been home to a range of conflicts and wars event-linked public health emergencies since the era of colonisation up to date. From West to Central Africa, Liberia, Sierra Leone, Guinea political unrest and long wars to Nigeria Biafra war activities of the armed group that calls itself Islamic State's West Africa Province (also known as Boko Haram) continues throughout the Lake Chad region along with its neighbours Cameroon, Chad and Niger related displacement and refugees emergency health issues and challenges [2,4,5].

Conflict-related public health outbreak emergencies have been documented over time in Africa and still remain a topical issue in fragile countries, displaced populations and refugees camps to residents of host communities in Nigeria, Kenya, DR Congo and Angola, Cameroon, Central African Republic (CAR), Senegal, Mali, Niger, Zimbabwe, Gabon and Congo. Moreover, South Sudan, Somalia to Eritrea and Kenya maintains its support for combat operations against the armed groups and terrorism [1,2,3,4]. Political concerns and socio-economic frustrations still persist throughout the region; governments maintain tight security measures in response to, and to forestall, insecurity and unrest. The spill over effects of the conflict continues to affect communicable diseases emergence and spread humanitarian needs. Central African refugees are still present in eastern Cameroon and northern DR Congo as the overall security situation in the (hereafter CAR) remains fragile and displaced population remain in need humanitarian assistance [5,6]. In the Congo, Cameroon, Gabon to CAR and South Sudan and Kenya, political tensions occasionally culminate into violence, arrests and episodes of temporary displacement, exile and refugees [2,4,6]. Conflict and civil wars to political unrests have left several consequences including huge socio-economic losses across Africa [1,5], such as dysfunctional, inadequate and severely disabled health systems, high level of illiteracy amidst populations of years without education, lack of qualified health personnel and brain drain syndrome, chronic unemployment, fluid population movement and migration; fear, anxiety and hostility, rumours and Ebolaphobia, discrimination and stigmatization, lack of portable water and environmental sanitation, lack of integration of African traditional medicine in the health systems and other sociocultural factors such as traditional burials and funeral practices involving close contact with the corpses threatening national security and international responses [3,6]. Nevertheless, the lack of access to basic healthcare was reported to 8.8 million living in severely affected areas at risk of life-threatening illnesses made worse with rising prices of food commodities and severely food insecurity. In addition, weakened or interrupted functioning health facilities had been damaged or destroyed in the conflict zones. Other challenges includes depletion of essential medicine, equipment and staff shortages, lack of or epileptic electricity supplies, portable drinking water and fuel, coupled with insecurity and damage to markets and roads also prevented supplies from being distributed timely and effectively [4,5,6,7].

Documented public health emergencies research and evidence knowledge are sporadically and randomly distributed across the region and perpetuated by a variety of ill- actions ranging from conflict, wars and political leadership

motivated civil unrest, ethnical genocide and mining groups incursions [1,3,5,6]. But also, most conflicts are accentuated by local insecurity and volatility linked population displacements and resettlements to regional neo-colonial excitements splintering across African conflict-fragile countries with few effective and stable peace and reconciliation, leadership and functional competency processes and strategies [1,4,5,6]. In addition, African governments exhibit significant distinctive intra and inter country conflicts types and events as well as diverse conflict trends and patterns. How do conflicts/wars and displaced populations events bring about Ebola outbreak public health emergencies in Africa? Can peace-building and conflict resolutions reduce or enhance public health humanitarian emergencies (outbreak or disaster crisis / catastrophe) preparedness, control and resilience in Africa?

Few previous studies have documented that infectious diseases mainly Ebola virus outbreaks public health emergency linked to conflicts/wars or disaster crises events extend and severity across Africa. The relationship between conflicts/wars events, population displacements and resettlements implications on Ebola outbreak emergence and spread in most Ebola affected communities is still poorly understood [1,4,7,8]. Tackling the growing and persisting conflict burden and challenges requires understanding the multifaceted effects and benefits that ranged from access constraints to humanitarian aid or relief, damaged infrastructure and unreliable access to fuel, together with lack of funding, has hampered their efforts.

The article examines conflict/wars related displacement and incursions events and impacts on alarming West Africa EVD outbreak public health emergencies consequences, and provides practical and effective evidence-based knowledge linked emerging infectious diseases outbreak public health emergencies preparedness, improving coordinated humanitarian assistance and emergency management strategies. Moreover, in nurturing peace-building and non-violence practice to conflicts and wars events towards promoting resilient health system strengthening and health equity, social justice and economic prosperity within Africa territories and globally.

2. METHODS

2.1 Search Strategy and Scrutiny

The systematic review dataset was collected from PubMed and acknowledged website searched based in West Africa region conflict events to emergence and spread of Ebola outbreak emergencies in the affected countries without restriction to language of studies published from January 1, 1960, to July 31, 2017. We used the Uppsala/PRIO Armed Conflict Dataset (ACD) and "conflict, location and resettlement/ displacement public health emergencies events dataset [4] which contains information on the geo-location of conflict events impacts in West African countries over the period 1997-2010 and other reference United Nations (UN) reports on conflicts, peace and conflict resolutions meetings in West Africa Ebola affected countries. A unique feature of ACLED dataset is that it contains information on the type of events, as well as the characteristics of the actors on both sides of the conflicts, events trend and patterns from 1997- July 31, 2017.

2.2 Selection Criteria and Assessment

To assess both the direct and indirect impacts of conflict/wars and Ebola outbreaks, we used the following keywords: "Ebola epidemics or outbreaks linked conflict/war, civil unrest," "political unrest, political instability," and "displacement, resettlement, humanitarian assistance for displaced or refugees' camps public health emergencies". To assess articles that focused on Ebola outbreaks and conflicts zones we used free text and MESH terms (where available). These conflict events public health emergencies are obtained from various, including national, annual reports, regional and local conflicts proceeding and humanitarian agencies or research publications. Exclusion criteria were determined a priori such as Ebola outbreaks editorials, view point or protocol guidelines and letters in isolated case report in military or tourists.

2.3 Statistical Analysis

Data were analysed using Statistica version 12.0 software frequency of exposure, resurgence of diseases throughout the duration of conflict and post-conflict EVD outbreak public health emergencies prevention and management or humanitarian assistance or relief. Analyses were

two-tailored with a significant P- value threshold set at less than 0.05. Correlation analyses were performed between war duration, years for epidemic minus war start, years for epidemic minus war end, cumulative cases (n) and cumulative fatality rate (%).

3. RESULTS

Of the 304 publications produced by the search strategy, 56 reported conflicts and infectious diseases and 19 reports describing conflicts-related separate outbreaks were evaluated, found eligible and analysed.

3.1 Trend and Pattern of Political Conflict/Wars Duration and Ebola Outbreaks in African Countries from 1960 -2015

The trend and patterns of conflict events related public health emergencies in Africa countries were diverse and complex ranging from civil unrest and wars associated displacement, diseases outbreaks (Ebola, Cholera, Polio, Meningitis, Rift Valley Fever, Dengue), natural disaster events (climate change and global warming impact, Droughts related hunger and famine, deforestation and intense mining, flooding and mud-/landsliding, volcanic eruptions and coast sea rise or *el-nino*). The pattern of these situations were multi-faceted and complicated by where rebels and militias or terrors capitalized on wild and forest jungles to hide, plan and stage their plots against the opponents to mining conflicts linked population displacement and forest incursions and wildlife those varied from one fragile country to another. The duration of conflict/war events varied from one to forty three years. Notably, the Darfur war in Sudan between 18-23 years, RD Congo and Guinea incessant political and ethnical or mining conflict instability repeatedly ranging between 2-6 years; whereas Liberia and Sierra Leone 5 and 12 years conflict/war events were documented in Liberia for seven and four years of conflicts from 1989-1996 and 1999-2003 prior to a democracy nation. Worldwide, there have been 28,639 cases of Ebola virus disease and 11,316 deaths as at December 2016. The most affected countries were Liberia and Sierra Leone and Guinea with a total of 10,675 and 11,123 cases, and 4,809 and 3,956 deaths respectively (Table 1).

Interestingly, the total Ebola outbreaks fatality rate in Liberia and Sierra Leone alone was greater than the documented cumulative fatality rate in Sudan, DR Congo, Congo, Gabon, Uganda, South Africa, Nigeria and Mali. The geopolitical ethnic rebels and militias or terrors conflicts, repression and fragility showed to influence greatly Ebola geographical distribution in the region. In addition to ethnic, religious and economic divisions to gain control of political power, and natural resources, conflict and war events appear to be directly linked to persisting emergence and re-emergence of Ebola outbreaks (e.g., DR Congo, Congo, South Sudan and Uganda) compared to the most affected West Africa communities (Table 1).

3.2 Correlation between Conflict/War Event Duration Displacement Impacts on Geographical Distribution of EVD across Affected Countries

The duration of conflict/war events in fragile conflict zones and displaced populations varied weeks to years across community and country. The longest duration was recorded in Sudan with 17 years (1955-1972) prior the first Ebola outbreak in Sudan in 1976 Uganda (1979-1986 prior to their first Ebola episode in 2000, and 1993-2003 with the 2007 and 2012 Ebola outbreaks respectively. Guinea in West Africa also recorded the constant instability with Liberia 7 and 4 years conflicts and wars from 1989-1996 and 1999-2003 respectively. As well as conflict in Sierra Leone broke out from 1991-2002 (10 years) with the cumulative resulting effect and emergence of West Africa Ebola outbreak. Conflicts/wars fragile African zones have also lasted longer, on average they lasted averagely weeks to eight years. There was a strong and statistically significant correlation between conflict/war event duration, years of Ebola epidemic minus war onset and cumulative cases and cumulative fatality rate to Ebola outbreak in Africa (R=0.57, P=0.0016; R=0.74, P=0.000). Also, there was a weak negative correlation between the conflict/war event duration and years of Ebola epidemic minus conflict/war end. Our findings showed the duration of conflict/war could be responsible for human displacement, forest and wildlife incursions and hunting as the source of food (Table 1). Community or national/sub-regional instability was documented at different time points across Africa and probably the epicentres, were areas of former resettlement, neighbouring districts and communities where wildlife reservoirs have been in close interaction(s) and/or exposed, and

spread of noxious traditional burial cultural practices rendering the environment and populations more susceptible to EVD outbreaks.

3.3 Building and Strengthening Early Preparedness and Response Resilience Capacity to Future Public Health Emergencies

Promoting and strengthening Public Health Emergency Response (PHER) Framework implementation as recommended by, the WHO and adopted by the Africa Union is needed. Strengthening local and regional public health emergency surveillance, preparedness and response benefits and gains to conflict-related infectious diseases threats and outbreaks public burden and multifaceted effects compared to the existing reluctance and inaction. Moreover, promoting collective engagement and commitment to accelerate International Health Regulations, 2005 implementation demonstrates the resolve of African countries governments to strengthen public health systems and core capacities critical to address the health biosecurity. It is important to note that strengthening local and regional research collaboration and network is needed for evidence translation into robust and effective conflict prevention and mitigation action in infectious disease burden control programs and poverty alleviation.

Regional and global humanitarian assistance commitments remain and rely on mobilizing philanthropic funding from member states and other partners. For example, the West Africa EVD outbreaks has taught us that WHO Grade 3 PHEIC declaration delaying an announcement imperils lives and health systems and more economic losses, and undermine domestic political legitimacy those motivate responses to international emergencies and establishment of a US$100 million contingency fund for rapid response WHO, UN and other humanitarian organizations including NGOs. Yet, 2014-2016 West Africa Ebola outbreaks pledges remain unfulfilled and need can be fulfilled for sustained investment by global partners in strengthening establishment and functioning of a global emergency fund in public health emergencies capacity development and training of local health workers. Thus, leveraging on proactive planning and quality preparedness of citizenry and professionals' knowledge and skills capabilities is necessary in prevention and control of potential emergencies situations including biothreats and zoonotic diseases outbreaks. Moreover, strengthening integrated public health emergencies early warning alert and surveillance, timely risk communication, community awareness and engagement strategies, and quality management practice in accordance with IHR, 2005, and Human Rights. Upholding global health security Alma Mata and principles is essential to protect and care for the most vulnerable groups of children and women to humanitarian workers and volunteers' safety and security is necessary in current and future conflict/wars-related public health emergency events in Africa and elsewhere.

Recent decades have witnessed increasingly globalized infectious disease outbreaks due to displaced populations in refugees' camps, population growth and increased cross-border movement (trade and travel), climate changes and environmental degradation across Africa. There is an urgent need to increasing public health emergencies partnerships and collaborative capabilities of local institutions, researchers and private sectors to rapidly identify, investigate, track or map and define contextual acceptable response approaches and strategies development and implementation is crucial. Concerted and sustained local and global public health community efforts in more granularity, development of public health emergencies practices, quality monitoring indicators and metrics, guidelines and best practices is important in risk stratification in different susceptible geographic settings earlier disease outbreaks surge responses.

Likewise, documented prolonged periods of civic unrest and insecurity linked localized epidemics before they reach epidemic proportions require proactive funding mobilization and prompt resource allocations for early preparedness and effective response. For example, the impact of decimated health systems and food insecurity in affected countries with limited human resource capacity led to re-emerging and emerging outbreaks as documented in Nigeria Ebola and Lassa fever outbreaks, Guinea, Sierra Leone, and Liberia rebuilding from 2014 West Africa EVD outbreak. This situation is compared to unstable DR Congo with persistent Ebola outbreak in different parts of the country since 1976 to early 2017 episodes, with challenging humanitarian assistance access and emergency response delivery in remote forest zones.

Table 1. Trend and pattern of political conflict/wars events and Ebola Outbreaks in African countries from 1976 -2016

Country	Conflict/War start year	Conflict/War end year	Conflict/War duration (years)	Ebola species	Ebola epidemic year	Years for Epidemic minus war start	Years for Epidemic minus war end	Cumulative cases(n)	Cumulative deaths(n)	Cumulative fatality rate (%)
Guinea	2009	2010	2	Zaire ebolavirus	2014	5	4	3,804	2,536	66%
Liberia	1999	2003	5	Zaire ebolavirus	2014	15	11	10,675	4,809	45%
Sierra Leone	1991	2002	12	Zaire ebolavirus	2014	23	12	11,123	3,956	32%
Nigeria	1967	1970	4	Zaire ebolavirus	2014	47	44	20	8	40%
Mali	1960	2012	2	Zaire ebolavirus	2014	2	2	8	6	75%
Senegal	2010	2012	3	Zaire ebolavirus	2014	4	2	1	0	0%
South Sudan	1955	1972	18	Sudan ebolavirus	1976	21	4	284	151	53%
South Sudan	1955	1972	18	Sudan ebolavirus	1979	24	7	34	22	65%
South Sudan	1983	2005	23	Sudan ebolavirus	2004	21	-1	17	7	41%
Gabon	1960	1963	3	Zaire ebolavirus	1994	34	31	52	31	60%
Gabon	2000	2000	1	Zaire ebolavirus	2002	2	2	65	53	82%
Congo	1996	1997	2	Zaire ebolavirus	2002	6	5	59	44	75%
Congo	1996	1997	2	Zaire ebolavirus	2003	7	6	143	128	90%
Congo	1998	2003	6	Zaire ebolavirus	2003	5	0	35	29	83%
Congo	1998	2003	6	Zaire ebolavirus	2005	7	2	12	10	83%
Uganda	1998	2003	6	Zaire ebolavirus	2000	2	-3	425	224	53%
Uganda	1998	2003	6	B. ebolavirus	2007	9	4	149	37	25%
Uganda	1998	2003	6	Zaire ebolavirus	2011	13	8	149	37	25%
Uganda	1998	2003	6	Sudan ebolavirus	2012	14	9	7	4	57%
DR Congo	1960	1965	6	Zaire ebolavirus	1976	16	11	318	280	88%
DR Congo	1960	1965	6	Zaire ebolavirus	1977	17	12	1	1	100%
DR Congo	1960	2017		Zaire ebolavirus	2017	8	4	4	813	50%
DR Congo	1960	1965	6	Zaire ebolavirus	1995	35	30	315	254	81%
DR Congo	2005	2006	2	Zaire ebolavirus	2007	2	1	264	187	71%
DR Congo	2005	2006	2	Zaire ebolavirus	2008	3	2	32	14	44%
DR Congo	2008	2008	1	Zaire ebolavirus	2012	4	4	57	29	51%
DR Congo	2008	2008	1	Zaire ebolavirus	2014	6	6	82	50	61%
Ivory Coast	2008	2011	4	Taï Forest ebolavirus	1994	-14	-17	1	0	0%
South Africa	1948	1994	47	Zaire ebolavirus	1996	48	2	1	1	100%

Investing in Public health emergencies preparedness and response capabilities in conflict prone settings in Africa is core in and require the establishment of robust and resilience local and regional public health emergency health policies, and integration into national health agenda. While exploring local public health disaster insurance schemes, insourcing and outsourcing supply chain procurement processes and life emergency fund from all stakeholders. where routine weak health systems, limited diagnostic tools and resources for structured surveillance and data transmission are lacking to stem the Ebola virus disease epidemic is laudable but should not encourage complacency in our efforts to improve the global public health infrastructure concerted international response is required to prevent urgent natural, technological and others hazards and disasters occurrence and emergence before they become catastrophic.

4. DISCUSSION

The devastating effects and the aftermath of political violence, civil war and ethnic conflicts have generated millions of displacement and resettlement with unbelievable pictures of suffering and unnecessary associated persistence of Ebola outbreaks and emerging infectious diseases mortality and disability across the African continent [4,9,10,11,12,13]. Africa is still facing complex conflicts and political instability where the vast majority of man-made conflicts and public health emergencies reported yearly since post-colonization included ethnic divisions and civil wars, civil or political conflict, battle over local natural resource ownership and benefits sharing inequities due to international commodity pricing and demand, fragile institutions and systems [4,13,14,15,16]. It was documented that the basic Human Rights, healthcare delivery and food security acute to severe shortages responsible for the public health emergencies during reported armed conflict, civil disturbance, state incursion and repression across Africa [6,9,14,16,17,18,19]. Attacks on and interference with health care providers, facilities, and services pose enormous challenges to effective health care delivery where it is most needed [4]. African populations continue to suffer from many different consequences of violent conflict, wars and forced mass migration since the early day of colonization up to the contemporary neo-imperialism facets. They are challenged by highly significant risk and impact of poverty related disease outbreaks including Ebola, cholera and HIV/AIDS pandemics, unemployment, low and loss of income owing to mortality and disability, and disruption in economic activity and uncertainties that increased cost of doing business, and capital flight leading to socio-economic consequences and humanitarian crises [6,12,13,14].

Since 2003 the Integrated Disease Surveillance and Response (IDSR) existed in Sierra Leone, but just like in most African countries remain dormant until when Ebola hit. The extent, to which Ebola spreads, therefore, depends on the actions of politicians, doctors, and patients and on how much those who are not infected trust their governments. At the very basic level, the local governments of Guinea, Sierra Leone, and Liberia need to focus on building a proper healthcare infrastructure, training medical professionals, and sending a unified clear message about Ebola to the masses [13,14]. In addition to the basic steps that West Africa needs to take to contain Ebola, is the need to encourage regional cooperation and cross-border collaboration in effective control as the strength of health systems varies across countries and an increase in health standards within each country is necessary for successful assistance and mutual trust in effective and timely cross-country information communication [1,6].

Public health epidemic preparedness measures to be taken should involve training staff to use surveillance tools and manage cases of epidemic-prone diseases and equipping them with reliable means of communication. Isolation facilities and high containment biosafety laboratories for pathogen confirmation must be identified in advance, and support must be provided to local institutions regarding training and supplying equipment and reagents. Data should be analyzed locally and regular feedback provided (e.g., a weekly bulletin) to health partners [2,4]. A rapid response mechanism for investigation alerts and implementation of control measures as outlined in outbreak preparedness plans (e.g., by an interagency outbreak control committee) are also crucial. Diseases threat and outbreak surveillance systems rely on close partnerships with NGOs, international organizations, and community groups and are built on resources and capacities of all organizations present. Effective surveillance systems in emergencies have involved selecting a small number of syndrome-based priority

events, using standard surveillance forms, simplifying case definitions; health facilities weekly reporting of data, immediate reporting if set alert thresholds are passed. Establishing community-based programs and mechanisms for identifying disease clusters. Improving detection and control of infectious diseases pre, during and post-conflict situations in any disaster risk and emerging infectious diseases primarily require a functional healthcare system, preparedness and response systems [2,12,14]. It is imperative that the technical capacity of all humanitarian health partners and ministries of health regarding disease surveillance, prevention, and control in conflict-affected countries be enhanced to ensure effective implementation of infectious disease interventions. Such implementation can be achieved through availability of internationally accepted standards, guidelines, and tools adapted to conflict situations, which can be supported by specific training of health planners and health facility staff, and rapid mobilization of international experts to provide technical field support as required. In poor resource settings such as Africa and elsewhere, building local, national and regional capacity peace and conflict resolutions, and disease prevention and control should be an integral part of programs implementation.

It is worth nothing that major humanitarian international and local non-governmental organizations (NGOs) have been created, with the purpose to improve the effectiveness of relief operations and to alleviate the suffering of these vulnerable populations. However, humanitarian aid logistics and coordination during previous decade had remained mainly justified on the basis of humanitarian geopolitical strategies and its charitable nature of emergency response, rather than its effectiveness [9,15]. More detailed investigations are required to establish the links between Ebola outbreak emergence and transmission dynamics pre, in or post conflict events. Such will include assessing the role of population displacement, forest and wildlife encroachment, ecological and environmental consequences on biothreats and public health crises. Conflict may lead to the displacement of large populations into temporary settlements or camps with overcrowding and rudimentary shelters, inadequate safe water and sanitation, and increased exposure to disease vectors during the acute phase of the emergency. In protracted and post-conflict situations, vulnerable populations in remote and hard to reach rural settings documented high morbidity and mortality rates due to breakdown of health systems, flight of trained staff, failure of existing disease control programs, and destroyed infrastructure [5,6,8,9,11,16,17].

Our finding showed the need for more operational conflict and outbreak crises humanitarian research for evidence-based public health emergencies programs and strategic actions. This should aim at proactive and resilient early peace-conflict prevention and resolutions, reducing conflict disabilities and consequences based on the understanding of spatio-temporal conflicts related public health humanitarian root causes and needs. But also, effective monitoring and evaluation of humanitarian relief programs effectiveness and performance metrics on quality lifelong health and economic development. Thus, informed policy-making through the provision of reliable evidence based knowledge and information for emergency decision making and response including rapid diagnosis, case isolation and management, contact tracing, safe burials, and the identification of transmission chain implementation and performance [6,16,17].

Our findings showed that conflict/war events affect the spatial and temporal patterns of Ebola outbreaks both in a quantitative and qualitative ways across affected African countries (Table 1). The history of conflict in the region and noted that after decades of civil wars in West Africa outsiders and authorities are widely distrusted as result in Guinea, Sierra Leone, and Liberia, the response to the Ebola outbreak has been highly politicized, with political factions pointing fingers at each other, further contributing to the social instability. Similar trends are beginning to be seen in the case of Ebola in West Africa. Violence against civilians in Guinea where a crowd attacked an Ebola isolation centers and threw rocks at aid workers, likely stemming from fear and misinformation about the disease, was seen as early as April 5, 2014 with the first official diagnosis of the disease probably as result of three instances of violence against civilians occurring in Guinea in 2014 thus far [1,4,14,15]. Conflict prevention, peace and security training and awareness could provide several opportunities to civil society, and citizens highly vulnerable to the influence, governments and conflict early warning in Africa and elsewhere as capacity to respond to these complex challenges remains weak with structural weaknesses, requisite institutional capacity and frameworks and significant economic growth albeit obvious democratic government

and development gains. Some explanations have been given by Jonathan and colleagues (2008), however it can be directly established that the emergence of Ebola outbreak can be linked with years of conflicts, displacements, forest and wildlife insurgences as well as human hunt for food for survival in the wild Africa forest. It has also been shown that mining activities have direct and indirect implications on the wildlife and ecosystems leading to emergence and resurgence of known and emerging infectious diseases outbreaks [19,20].

In contrast to central Africa, DR Congo persistent conflict/war events instability in the military ruling era, the 1990s and 2000s periodic conflicts witnessed the highest second after Congo with more than 7 times episodes of Ebola outbreak in 1977, 1995, 2005, 2007, 2008, 2012 and 2014 compared to the first West Africa cases s in 2014 (Table 1). In West Africa, Liberia had a long civil conflict / wars from 1989-1996 and 1999-2000 respectively. Only this total fatality in Liberia is greater than the cumulative fatality rate in Sudan, Congo, Gabon, Uganda, South Africa, and Nigeria (Table 1). It could be demonstrated that DRC, Liberia and Sierra Leone's violence supports the notion that more events drive increase in locations and actors vulnerability to Ebola outbreaks and psychosocial challenges. The WHO is working with the governments of EVD affected countries to strengthen the health system, including bolstering the capacity of public laboratories to detect most existing infectious likely to cause epidemics [20,21]. Since the middle 1990s, wars and political instabilities in West Africa (Liberia, Sierra Leone, Côte d'Ivoire), Great Lakes and East regions (DR Congo, Uganda, Burundi, Rwanda, Ethiopia, Eritrea, Somalia) have forced millions of people to flee their homes or communities within and across their own borders stretching from northern Mali through Southern Algeria to Libya into Egypt. Nowadays, recent outbreaks on Cholera and Polio, Meningitis and Influenza to famine and malnutrition/food insecurity have been reported sporadically in conflict zones in South Sudan, Central Africa Republic (CAR) and Nigeria insurgency-related activity of Boko Haram and associated actors, DR Congo recent Ebola outbreak and Somalia continue to be worrisome due to high rate of displacement of indigenous populations and casualty attacks relatively bleak. Interestingly, in Uganda, more than half of the 1.8 million of internal displaced populations in 2005 returned homes by December 2009, similar to Burundi from 800,000 displaced in 1999 to 100.000 at the end 2009. With considerable decreased in recent years, strengthening African leaders political commitment is the most important factor in increasing financial resource capacity and peace building inspiring national patriotism and resilience, disarmament and reintegration post conflicts programs.

Conflict-affected countries represent one of the weakest links in global health security and should be prioritized by the international community in provision of technical and operational support to implement core capacities for detection and response to epidemics. The trend and patterns of conflicts war events in Africa countries is diverse and complex ranging from ethnic, civil to mining conflicts and varied from one country to another and resulting to incursion in wildlife and forest where rebels and militias or terrorists capitalized on wild and forest jungles to hide, plan and stage their plots against the opponents. Consequentially, insidious and spread of rape and sexual violence against girls and women, lack of food, shelter and medical access to forced recruitment of children into armed groups (e.g. BokoHarram in Northern Nigeria) have been documented. BokoHarram in Nigeria eight years conflict left more than 20,000 deaths and 2.6 million displaced in Nigeria, with spilled out violence in Cameroon, Chad and Niger, and creating major humanitarian catastrophes in refugees' camps in recent times [17,18,22]. Military humanitarian forces (local community, US, UK) were been deployed in most affected Ebola outbreak West Africa countries emergency humanitarian responses in 2014-2015 and slow down during recovery and rebuilding programs amongst survivors and affected populations [22,23]. These programs have a crucial role and are valuable resource in health systems development and socioeconomic growth. However, military humanitarian assistance in outbreak has not been fully elucidated and requires further attention in terms of neutrality, community liaisons, and cooperation, consistent and transparent policy and humanitarian interventions especially in previous war zones. Also, it might be of importance in avoiding resurgence of geopolitical conflicts, repression and fragility showed to influence greatly Ebola geographical distribution in the region. In addition to ethnic, religious and economic divisions, conflicts to gain control of political power, and natural resources appears to be directly linked to Ebola

outbreak in most affected communities in Africa [4,20]. Although the difficulty to access communities, security problems and poor communications and transport infrastructure, weak health systems and human health resources, poor leadership and the delay in international emergency response contributed to the worsening situation in the ongoing Ebola crisis in West Africa.

Based on the historical trends and dynamics patterns of instability and emerging outbreak in these countries, others countries worldwide suffering from similar challenges and issues in Africa such as central Africa Republic, Sudan, Libya, Burundi, Nigeria, Mali, Kenya, Rwanda, Niger, Somalia, Egypt, Tunisia, Algeria, Mozambique, Senegal, Madagascar, and Malawi can simply take the right steps in the right direction to avoid the horrors of Ebola and other emerging infectious diseases [18,19,20]. Again, lessons learnt from EDV outbreaks and conflict related public health emergencies consequences can serve in early warning alert and mitigation on incessant Middle East and Asia-Pacific countries whirling in the same dilemma and perpetual state of fragility including Syria, Iraq, Lebanon, Pakistan-Kashmir, Palestine, Myanmar, Sri Lanka, Thailand, as well as Latin America countries including Colombia, Guatemala, in Europe Northern Ireland and Western Balkans. Our findings provide evidence and information insights to leaders, organizations such as mining, policy makers and other stakeholders especially communities on their importance and role in seeking and undertakings rebuilding strategies pre-/post conflict events, and advocating on protection of environment and wildlife in Africa and elsewhere on sustainable national and global health, socio-economic and environment development and growth [3,22,23,24,25]. In 2016, the growth in displacement figures was largely driven by the conflicts, gender violence, hunger and human rights violations in Middle Eastern countries such as Syria, Yemen, Iraq and India-Pakistan border. But conflicts in sub-Saharan Africa also forced millions of people to flee their homes in countries such as South Sudan, the Central African Republic, Burundi, the Democratic Republic of Congo, and Sudan. The region also hosted a large and growing number of refugees, which continued to exert enormous pressure on public services and local infrastructure in neighboring countries far-reaching political implications. African governments and local and multinational actors including humanitarian organizations should agree to shoulder primary responsibility for preventing forced displacement, access to the displaced and delivery of relief supplies. Recent Cholera outbreak in Yemen requires detailed outbreak investigation and rapid assessment is currently ongoing due to limited local capacity. The source of this cholera infection needs to be quickly established to facilitate appropriate strategies and interventions for rapid containment. There is an urgent need to strengthen the cholera case management system as the current treatment centre falls short of the minimum standard. There is also a need to secure culturally fit-personal protective equipment, stock of medical supplies and dedicated personnel, in case of an influx of patients; likewise mudsliding and flooding related public health emergency disaster with potential cholera outbreaks threat in Sierra Leone that led to over 1,000 deaths in August 2017 [23,25]. Therefore, both public health emergencies events require urgent local and international requisite resources (mobilization and technical support in recovery and rebuilding (mental, food and social, human capacity, funds and logistics) efforts as well as urban planning laws and reforms are critical to strengthening Sierra Leone and other prone disasters countries public health emergencies preparedness and response capabilities.The insufficiencies in national and regional surveillance and early warning and emergency response systems showed to favor Ebola outbreaks in both urban and rural areas under natural and human made conditions. The central Africa of DR Congo neigbourshood area had been affected by civil war since 1997 and was controlled by Congolese rebels. Moreover, an estimated 850,000 children of 1.4 million indigenous populations have been forcefully displaced and horrific atrocities of committed with over 3,383 deaths in over 20 ethnic (Luba and Lulua) groups villages completely destroyed in Kasai provinces, DR Congo in due to constitutional crisis by violation of presidential term limits set out in the constitution, succession deal brokered and Bana Mura government-backed militia versus Kamuina Nsapu militia factions uprising since March 2016 to date. For example, Boko Haram terrorism and insurgence in Nigeria has been linked to political instability and insecurity, threatening displaced populations and local indigenous in northern Cameroon, Chad and Niger. Similarly, political instability, militia factions and ethnics' violence impacts in CAR and Burundi on neigbouring Uganda, South Sudan, DR Congo, Angola and other civil unrest in African countries remain of regional and global

public health concerns. African leaders have limited peace-building technical capacity and leadership competencies, peace-conflict resolution to public health laboratory know-how capacities, facilities and lack of technical expertise require an urgent attention. For example, in South Sudan, the situation has led to continued food insecurity as no tangible agricultural activities have taken place. The armed conflict has resulted in massive population displacement, disrupted people's livelihoods, trade and access to humanitarian assistance, which remains the main source of food and livelihood in the conflict areas. The situation is being compounded by the high food prices and economic meltdown, which has eroded household purchasing power. High levels of severe acute malnutrition remain a serious public health concern across South Sudan, being driven by widespread fighting, displacement and poor access to services, disease outbreaks, extremely poor diet and extremely critical levels of acute malnutrition, putting 45,000 people at risk of famine (in terms of both quality and quantity), low coverage of sanitation facilities, provision of healthcare services have been severely compromised, and poor hygiene practices [15,24,25]. Continuous support of displaced populations and refugees humanitarian crisis needs remain indispensible through local, regional and global humanitarian assistance and relief programs. For example, the recent upsurge of cholera in the populous cosmopolitan Nairobi city and refugee setting in the north-eastern part of Kenya has been driven by mass population movements across borders leading to high population density in peri-urban and refugees camps, low care access to unsafe water and sanitation, inadequacies to timely humanitarian care, shelter and food assistance by WHO, UN agencies, humanitarian organizations and other partners NGOs. Hence, developing and implementing mixed top-down and bottom-up multisectoral leadership engagement, community advocacy and resilience interventional strategies is needed to tackle complex public emergencies crises across Africa including improving access to early diagnostic screening, data sharing and treatment adherence against the rising antimicrobial resistance burden. Equally, scaling up vaccination programs (Polio, Rift valley fever, Measles and Tetanus, TB, Ebola, Zika, malaria) for vulnerable groups, improved vegetable seeds and fishing tools, better-quality WASH and borehole programs for vulnerable households and populations for cumulative positive socio-economic and public health benefits. Strengthening local and regional conflict-linked biothreats and disease outbreaks early detection, surveillance and monitoring implementation is crucial in generating evidence-based national public health emergency preparedness, prevention and control programs and countermeasures [24,25,26].

Hence, strengthening public health emergencies events surveillance, knowledge and abilities is crucial in investigating and monitoring invasive pest, effective integrated vector and associated diseases threats or outbreaks prevention and control programs. Improving refugees and displaced populations in South Sudan, DR Congo, Cameroon, Nigeria, Angola and Kenya and Ethiopia refugees camps to Mali and Libya migrants locations humanitarian rescue assistance access to quality care delivery, to safe potable water, proper sanitation and shelter is needed in line with International migration laws, Human Rights and sustained development of Africa. Authors recognized the urgent need to increase proactive and resilient leadership and investment is needed for local population awareness activities, behaviour social mobilization and resilience empowerment programs to ownership, while fostering youths and women entrepreneurship talents is imperative against public health related biothreats and disasters humanitarian crises in enhancing the economic, political, and social environments opportunities in the region.

However, it should be noted some conflict related data were obtained from geo-coding conflicts events in form ACLED and other international agencies datasets are not immune from potential biases and measurement, and not exhaustive. We cannot rule out the possibility of under-reporting of some conflicts and regional emergencies events towards some countries due to media coverage restrictions and access control.

5. CONCLUSION AND RECOMMENDA-TIONS

This paper provides the first comprehensive evidence-based conflict and wars public health emergencies associated Ebola outbreaks events implications in Africa and provide practical and effective approaches, programs and activities in full rebuilding processes (peacekeeping, peace-

building, conflict resolution, healthy outbreak recovery) for wellbeing and productivity. Authors call for the urgent need for concerned commitment and engagement of all stakeholders to develop, implement and strengthening local, regional and global public health emergencies evidence practice approaches and strategies including national public health disaster emergency situations insurance schemes in paramount in disaster high risk prone settings and particular in Africa is imperative to fostering health and socioeconomic development and growth. The importance of implementation of effective and timely outbreak early warning alert, surveillance and emergency response systems is recognised, but there is a scarcity of evidence on optimal ways to detect these outbreaks in most conflict eventful countries in Africa. Building evidence-based and effective public health emergencies partnerships and programs is critical through investing in Africa CDC centres core public health laboratory infrastructure and human resources capacity development; but also strengthening community-based programs and targeted training on outbreak epidemiologic and disaster risk surveillance and rapid response surge capabilities beyond. Global funding and local public-private commitment and investment including disaster public health emergency insurance model(s) and scheme(s) integration could be assets to deploy resources successfully and in a timely fashion to prevent and respond to disaster emergencies. The collective public health emergencies benefits is vital in health systems strengthening including substantial resource expenditures and routine full functioning health services successful implementation in line with IHR, 2005 and global community agenda against international infectious disease threats; while advocating for an effective implementation of WHO outbreaks emergency surveillance response systems recommendations in emerging tropical diseases elimination and eradication in Africa. Surveillance systems are often weak in conflict situations, which results in delays in detection, timely reporting and risk communication that can be addressed by revitalising by strengthening local and regional integrated disease surveillance and response systems implementation practice.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGMENTS

We are grateful for the support and cooperation institutions and collaborators.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/21330