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THE MULTIDIMENSIONAL IMPACT OF CBRNe EVENTS ON HEALTH CARE IN THE MIDDLE EAST: THE ROLE OF EPIDEMIOLOGICAL SURVEILLANCE IN THE LONG-TERM RECOVERY OF PUBLIC HEALTH SYSTEMS

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ABSTRACT

Chemical, biological, radiological, nuclear and explosive (CBRNe) hazards used as agents during conflicts and terrorism are a threat to any civil society, negatively impacting economical, human, political and environmental aspects. When a country is stricken by CBRNe, several related events can significantly debilitate the public health system's assets, placing additional demands on the health-care organization of the country and neighbors. The consequences for the health of a population might be both direct, such as deaths and injuries, and indirect with long-term aftereffects such as disruption of basic health services, damages to infrastructures and lack of medical personnel. This article provides an overview on the multidimensional impact of CBRNe events on the healthcare sector in the Middle East (Afghanistan, Iraq, Lebanon and Syria) and the countries' efforts in setting up the basis for health system recovery. Our main aim is to emphasize that the rebuilding of an effective healthcare system is a long-term process that requires multiple actions and actors, with epidemiological surveillance being the cornerstone. We maintain that reinvesting in effective health monitoring systems is essential to support countries in meeting the health needs of their populations in post-CBRNe events. This is the first necessary step for appropriately allocating resources, driving investment, setting up preventive strategies and decision-making responses. Furthermore, especially when referring to fragile states, acquiring knowledge on the health needs of the threatened population holds a paramount importance for providing preparedness planning and enhancing resilience of the public health system in case of future CBRNe events.

Keywords: *CBRNe events; epidemiological surveillance; health monitoring system; health system recovery; Middle East.*

1. THE IMPACT OF CBRNe EVENTS ON HEALTHCARE

The use of chemical, biological, radiological, nuclear, and explosive (CBRNe) agents during armed conflicts, as an act of terrorism or when accidents happen, can have complex and multidimensional impact on a country's structure, affecting from economic, political, social and health sectors to food security (Moramarco, 2018). Specifically, when referring to the health sector, all facets of a health system are likely to be stricken, especially during protracted long-lasting events: basic health delivery services are jeopardized through general damage and specific destruction of health structures - as recently happened in Iraq (The Guardian, 2016) and Syria (The Washington Post, 2018) - with health facilities sometimes becoming specific targets of strikes. Consequently, human capital and medical staff are suppressed, with medical personnel directly killed or forced to flee, looking for better life conditions and a more comfortable environment to work in. The crippling of healthcare infrastructure compromises routine health delivery systems - at times vaccines and other lifesaving drugs have been intentionally blocked from reaching civilians (The National, 2018) - creating a population susceptible to potential disease outbreaks (Nnadi *et al.*, 2017). When outbreaks occur in these settings, they rapidly spread, often with a high probability of prolonged transmission, owing to unavailable treatment facilities, and poorly trained or lack of health personnel, coupled with population displacements. These are all events that significantly heighten the risk of disease transmission, as well as

increase the morbidity and mortality rates of the affected population (Murray *et al.*, 2002). Indeed, populations that have experienced such events present the worst indicators of infant, child (Black *et al.*, 2003) and maternal mortality (Johnson, 2017). In addition, even neighboring countries are threatened not only because of the direct consequences of CBRNe, but also for their indirect impact: people forced to flee increase the number of displaced people and refugees, putting more pressure on the health services of the hosting countries; and outbreaks of infectious diseases can easily spread, representing a global public health hazard (UN News, 2018). Refugee camps experience the highest rates of infection and case fatality due to scarce resources (Brown *et al.*, 2002).

The countries' first priority becomes limiting injuries and deaths, with public investments inevitably drawn away from sustainable development goals and redirected to emergency response activities, but also to military and defensive pursuits. In such settings of security and time limitations, assessing healthcare (both health needs of the population and availability of health services) is not easy. Lack of systematic information gathering hampers effective decision-making, mobilization, resource allocation and advocacy for health. This complex scenario can last even long after the emergency cessation.

2. LONG-TERM RECOVERY OF HEALTH SYSTEMS IN POST-CBRNe EVENTS

The recovery of health systems after direct CBRNe events or their indirect consequences is a complicated endeavor and a long-term process that requires multiple human and financial investments (Rutherford & Saleh, 2019). Recovery is defined as the process of rebuilding, restoring and rehabilitating the public health system following an emergency; it includes remediation techniques that may be applicable to facilitate the return to normality, as well as moving to self-sufficiency, sustainability and resilience. While the immediate response to an emergency can be relatively short, recovery is a long-running process that continues until the disruption is rectified, the needs of the affected are met, and the demands of services are satisfied (HM Government, 2013). This long-term phase can last months or even years, as its aim is to revitalize, rebuild and repopulate / re-use affected areas, favoring the progress to self-sufficiency, sustainability and resilience.

Recovery should be considered not only as a response to a specific disaster, but since the latter might be due to lack of preparedness, it has to be considered also as the basis for future readiness. Preparedness includes plans to be prepared for, and respond to, a wide range of hazards and threats, essential to save lives and to facilitate early response and timely recovery operations in case of future emergencies. It is, indeed, important to provide continuity plans integrated into wider emergency plans (Boyd *et al.*, 2013). Therefore, monitoring the needs of populations in terms of health and availability of health services - tracking their evolution over time - requires tools for information gathering and data analysis in order to drive effective decision-making, as well as mobilization and resource allocation.

2.1. Epidemiological Surveillance as the Basis for Health System Recovery

Especially in fragile states, the reconstruction of a functional public health system – which includes stabilization initiatives and investments in reestablishing or in some cases establishing for the first time a system of health services for the population - is a key element to address both the acute and ongoing health needs, to guide decisions, and to optimize future activities (OECD, 2011). The priorities and resources devoted to planning, preparedness, and response are of paramount importance, and the only way to appropriately allocate them is conducting a reliable initial situation analysis and a routinely epidemiological surveillance¹. As applied to public health, the term “surveillance” means the close monitoring of the occurrence of selected health conditions in the population (Berkelmann *et al.*, 1997). In 1963, disease surveillance was defined as “*the continued watchfulness over the distribution and trends of incidence through systematic collection, consolidation, and evaluation of morbidity and mortality reports and other relevant data*” (Langmuir, 1963), which implies information for action (World Health Assembly 21, 1968).

¹ “*Epidemiological Surveillance is the ongoing, systematic collection, analysis, interpretation, and dissemination of data about health-related events for use in public health action to reduce morbidity and mortality and to improve health*” (Centers for Disease Control and Prevention, 2001).

Surveillance data can be in fact also used to detect changes in health practices, evaluate control measures, and describe the natural history of a health event in a community. Therefore, since it is crucial to identify the important contextual variables that influence the country's assets and development, surveillance requires commitment to data collection. Its ultimate goal is the formulation of public health policies to promote health and prevent diseases (Bonita *et al.*, 2003).

After CBRNe events, as well as during conflicts (especially when protracted), affected local governments are often deeply weakened, having usually limited capacity and resources to manage on their own all the necessary reconstruction tasks. Therefore, public health recovery is generally also supported by private or international donors (Rubenstein, 2009). These principles go along with building the capacity of the local health authorities to engage in the essential tasks of leadership, planning and oversight.

3. EVIDENCE FROM MIDDLE EAST COUNTRIES

Examples of the devastating effects of CBRNe events on countries' asset come from the Middle East. The location of the region's confines, generally on the eastern side of Mediterranean Sea, has always led to some confusion over changing definitions (Hazbun, 2012). In the most common definition, usually the region comprises of Afghanistan, Bahrain, Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Pakistan, Palestine, Israel, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates, and Yemen. Historically, the Middle East has been one of the most critical regions of the world. Crises in the region resulted from various reasons, and led to long-lasting conflicts and terrorism attacks, most of which have involved CBRNe agents, or have been triggered by their real or perceived threats. Such events had a major impact on health systems and, consequently, on populations' health (Coutts *et al.*, 2013). A recent Global Burden of Disease Study (GBD 2013) analyzed the burden of disease and injuries in the eastern Mediterranean region as of 2013, when the region faced unrest as a result of revolutions and wars during the so-called Arab uprisings (Mokdad *et al.*, 2016). The study showed that the eastern Mediterranean region was going through a critical period of the health sector, with a call for increasing health investments in the region, in addition – of course - to reducing conflicts.

In the Thirteenth General Program of Work for 2019–2023 (GPW 13), the World Health Organization (WHO) emphasized the need for reliable and timely health information in order to ensure healthcare delivery, health policy development and implementation, with the strengthening of health information systems being a priority in the region (WHO, 2018).

3.1 The Case of Afghanistan

Afghanistan had a reasonably functioning health sector before the Soviet invasion in 1979, when the country entered into a prolonged war. There have been reports that both Soviet and Mujahedeen forces used various types of chemical agents (US Department of State, 1982). Such reports were mainly based on testimonies and on some symptoms of the victims; thus, they have never been confirmed. Details and official documentation on the use of these agents are indeed still lacking (Schwartzstein, 1982). Following the Soviet withdrawal of 1988-1989, Afghanistan plunged into a civil war, resulting in the rise of the Taliban regime, which exacerbated the already compromised situation. After the September, 11 terrorist attacks in 2001, the US-led intervention resulted in the fall of the Taliban regime. In 2002, when the transitional government, with the support of the international community, tried to re-establish systems and services in all sectors, it became clear that physical and social assets were severely damaged, although little information was available about their extent (Fujita *et al.*, 2011).

Today, the country is still facing challenges and fragility. Several chemical attacks have been reported (55 between 2008 and 2013, with 55 people killed and 2,683 injured), but not all of them were confirmed (Johnston's Archive, 2015). For example, in 2012, 16 poison attacks on high schoolgirl in the Northern Region, Takhar province, were reported. Several – may be all - of these cases seemed to involve poisoning of the school's water supply; overall, 1,355 children and 28 teachers and staff were reported injured in these

attacks. However, WHO inspectors did not confirm the presence of a poison, alleging that the cases might be the result of mass hysteria (Johnson, 2015).

As a consequence of all these events, many health infrastructures were damaged and the health system almost stopped working (Cook, 2003). Afghanistan's health system has become one of the worst in the world, with destroyed public structures, reduced technical and health staff (killed or forced to live in exile), and no investments made in the health sector. One of the major challenges has been the unavailability of medicines and the low quality of the few available drugs. In 2002, health indicators were very poor, including a maternal mortality ratio of 1,600 per 100,000 live births, an infant mortality rate of 165 per 1,000, and an under-five mortality of 257 per 1,000 (Waldman & Hanif, 2002; Bartlett *et al.*, 2002).

The post-conflict situation provided a unique opportunity to redesign and rebuild the health system, almost from scratch, with the Ministry of Public Health (MoPH) promising on various occasions that there would be extra attention (The Daily Outlook Afghanistan, 2017). One of the earliest activities in the health sector was the national health resources assessment, in 2002, when available resources in the country (human, material, financial) were mapped (Ministry of Health Transitional Islamic Government of Afghanistan, 2002)².

To reverse this decline, the MoPH began working with the international community and civil society, first to provide emergency health services to a long-suffering population, and then to reconstruct the health system. The establishment of a "Basic Package of Health Services", with a major expansion of the availability of primary health services and the reach of vaccination programs, started to bring important improvements in key health indicators (Ministry of Health, Transitional Islamic Government of Afghanistan, 2003). To give an example, in 2010 infant mortality fell to 77 per 1,000, while under-five mortality decreased to 97 per 1,000 (USAID, 2014). Nowadays, the WHO is still providing technical assistance to the MoPH for the implementation of the National Disease Surveillance and Response system (NDSR), including the Early Warning component for responding to epidemics outbreaks.

3.2 The Case of Iraq

In the 1970s, the Iraqi health system was one of the best and most advanced in the Middle East (Middle East Health Magazine, 2012). However, its capacity and performance started to deteriorate during the 1980s, then further worsening in the last few decades as a result of continuous wars, sanctions, loss of health workers, looting, political interference, and economic sanctions. Some of those events have been a direct consequence of CBRNe events or their perceived threats. During the Iran-Iraq War (1980-1988), the use of *samarium*, *tabun*, and *mustard gas* on a large scale was reported against both Iran and the Kurdish populations in northern Iraq. For a period of about five years from 1983 to 1988, the Iraqi army used chemical weapons several times (Razavi *et al.*, 2014). The worst attack was conducted in 1988 on the Iraqi Kurdish town of Halabja. The event was also known as the Halabja Massacre or Bloody Friday,³ since it was one of the deadliest chemical attacks in history after the First World War (Hiltermann, 2007). The chemical gasses lasted some 45 minutes, causing 6,000 civilians deaths, 5,000 of them within less than 10 minutes (eight times more than the daily victims of one of the big epidemics of the middle ages) (Mohamed-Ali, 1992; The New York Times, 2003). Severe damage was reported in people exposed - between 7,000 to 10,000 - most of them civilians (The Times, 2010). Before and after the attack on Halabja, poison gas was used in various other towns and villages in the border regions with Iran and Turkey during the so-called Anfal Campaign (Mlodoch, 2017). Those events triggered the involvement of multinational military operations, from the US-led, which dragged the country into recurring and long-lasting conflicts, up to the recent ISIS (the so-called Islamic State) occupations. Nowadays, Iraq is still one of the world's most landmine-affected countries: years of conflicts have left landmines, cluster munitions, and unexploded bombs all over, preventing

² One of the main findings was the limited number of female health professionals (approximately one female doctor, one female nurse and one midwife for every 50,000 individuals). This was a major constraint, which resulted from the post-Taliban society.

³ The attack was conducted by Saddam Hussein's forces in the final months of the eight-year Iraq-Iran war and was also part of Iraqi efforts to counter-attack Kurdish militias forces, supported by Iran.

communities from using their land and displaced populations from returning home (Mine Action Review, 2018).

One of the results of this complex scenario was that health indicators fell over the years to levels comparable to some of the least developed countries. Most updated health-care data, when available, confirms that the Iraqi population is still paying a crippling price for the continuing violence, political infighting and widely acknowledged rampant corruption within the health system (Webster, 2011). Over the years, the number of hospital beds in Iraq declined from a high of 1.95 per 1,000 people in 1970 to a low of 1.30 per 1,000 people in 2012 (Trading Economics, 2019). As a consequence of lack of proper sanitation system and inadequate timely response, Iraq experienced recurring cholera outbreaks in 2007, 2009, 2012, and 2015. In October 2007, the outbreak spread to 9 out of the 18 provinces across Iraq, with more than 3,315 blood samples testing positive for *Vibrio cholerae*, the bacterium causing the disease. Fourteen people died from the disease. The most affected areas were Kirkuk (2,309 cases) and Sulaymaniyah (870 cases). In 2015, Iraq faced an outbreak of cholera that started in September along the Euphrates valley. A total of 2,810 laboratory-confirmed cases of cholera, from 17 governorates, were reported by WHO from mid-September to November, with two related deaths (WHO, 2015). The health system received a shock after the ISIS took over about one third of the country in 2014. Nowadays, in spite of the defeat of ISIS and much rebuilding, health infrastructure is still not fully restored (Devi, 2018). In terms of areas of displacement, at the end of 2018, the Kurdistan Region of Iraq was the area hosting the largest number of internally displaced people - IDPs: 1.8 million people, a nearly 30% increase in the population of the region (IOM, 2018). The increasing number of displaced people and, consequently, their disease caseload poses new challenges to the local government and humanitarian agencies in the provision of health care, diagnostics and medications. In particular, concern has been raised on the access to care among minority groups displaced by ISIS, such as the Yazidis (Cetorelli *et al.*, 2017). Moreover, the latest offensive of the Turkish army against the Kurdish population in Syria is a rising concern for new refugee flowing to the Iraqi Kurdistan Region (KRI) (north of Iraq), with the reopening of refugee camps.

Field researches conducted in the KRI before the refugee crisis found that if the population continued to grow at current rates and physician utilization rates were similar to nearby countries, the KRI would have needed an additional 2,097 physicians by 2020 (an increase of more than 33%) (Moore *et al.*, 2014). However, contrary to the national needs, many skilled health workers and young graduates have continued to leave.

National development plans call for a realignment of the health system with primary health care as the basis (Al Hilfi *et al.*, 2013). Several problems in the epidemiological monitoring system have been identified. Specifically, existing data collection and use is fragmented, inconsistent and often of poor quality, with routine data collection not standardized across the country. The result of it is inadequate knowledge of the health status of the population and insufficient understanding of its needs, limited public health vision and organization, as well as lack of prevention activities and preparedness response plan (Ross *et al.*, 2017). For example, despite 30 years having passed since the chemical attack in Halabja, the Kurdistan population continues to suffer from its long-term psychological, health and environmental consequences (Mlodoch, 2017). After many years, survivors are still reporting chronic symptoms, such as respiratory, digestive and neurological disorders; increased miscarriages and infertility; blindness; leukemia, lymphoma and other cancers; post-traumatic stress disorder, depression and feelings of guilt, aggression, and alienation; as well as congenital malformations and other birth defects (Jiyan Foundation for Human Right, 2014). These deteriorated medical conditions put survivors in need of continuous medical care and support. Additionally, mental health with declared psychiatric and social dysfunction, have been observed even decades after the initial incident. Consequences are found not only among survivors but also the second generation seems to be affected. These observations call for field-researches and for further investigations. Recent articles have suggested that the long-term impact of war on psychosocial, physical health and emotional life is often overlooked by policy makers, despite the evidence that traumatized populations remain disadvantaged on a number of economic and social fronts long after fighting has ceased (Galea *et al.*, 2003). Further researches are needed to determine the societal costs of human rights abuses and to identify groups of persons at increased risk of psychological dysfunction years after the fighting stops (Dworkin *et al.*, 2008).

In order to respond to these health priorities, the University of Rome Tor Vergata (Italy) and Ministry of Health of KRI have been implementing, since 2015, an electronic system for epidemiological monitoring and health surveillance in the Kurdistan Region, with the aim of extending it to the whole of Iraq. The system - launched by means of the project “Development and Implementation of a Health Monitoring and Epidemiological Surveillance System in Iraqi Kurdistan” - has been designed to manage healthcare data, by collecting, storing, managing, and transmitting patients’ electronic medical records, including diagnoses, vaccinations, births and deaths. At the end of October 2019, 59 centers were active, with more than 600,000 disease events recorded in the four governorates of Dohuk, Erbil, Halabja and Sulaymaniyah (Emberti Gialloreti *et al.*, 2020a). The software is run by the health and administrative personnel of the local health centers, who have already been trained in data collection, analysis and disease coding (Moramarco *et al.*, 2019).

3.3 The Case of Lebanon

Since the 70s Lebanon has been threatened by years of social and political instability, deeply influenced by the neighboring Syria, which controlled Lebanon from 1976 to 2005. After Syria’s withdrawal, the Israeli and Hezbollah militias continued to attack and counterattack against each other, culminating in a war in 2006 that left much of south Lebanon devastated. The Israeli government admitted to have used phosphorus weapons in Lebanon during this conflict. These are not forbidden by international law but several experts believe they should be re-classified as chemical weapons. Despite the Israeli government claiming their use according to the rules of international law, there have been numerous reports that phosphorus munitions injured and killed civilians, with unexploded cluster bombs threatening the Lebanese population even after the end of the war (The Guardian, 2006).

Since the start of the Syrian crisis in 2011, in light of the volatility and complexity of the conflict, concerns exist over the potential for the Syrian regime to transfer chemical weapons to non-state actors, such as Hezbollah in Lebanon (Brooks *et al.*, 2018), that might also threaten a fragile peace in the country (The Globe and Mail, 2018).

Nowadays, Lebanon is indirectly experiencing the consequences of neighboring conflicts and CBRNe related events. With some 1.5 million Syrians refugees - about a quarter of the Lebanese population - in addition to a large community of Palestinian refugees, the country hosts the largest concentration of refugees per capita and the fourth largest refugee population in the world (Government of Lebanon & the United Nations, 2019). A robust response has been timely mounted by the local government in partnership with the international community, helping to avert dire consequences. Over the years, the situation for refugees has been stabilized and even slightly improved in many sectors, but over two thirds of Syrian refugees still remain in poverty and 90% are experiencing food insecurity. The large presence of displaced populations has increased demand on infrastructure and health services, which lack the capacity to fully meet the needs. Currently, nearly one third of refugee households remains unaware of where to access medical services in case of an emergency (UNHCR/UNICEF/WFP, 2018), suggesting the need for strengthening communication and preparedness. These impacts are likely to be significant, and to continue into the long-term, with particular concern for health security and the likely increase of infectious diseases risk (Republic of Lebanon MoPH, 2016). Overall vaccination coverage rates remain sub-optimal, with recently experienced outbreaks of vaccine preventable diseases (867 cases of measles in 2018) and water-borne diarrhea (Government of Lebanon & the United Nations, 2019). The pressure on healthcare institutions caused by the increased demand for services could be an additional potential source of conflict and CBRNe-related events in this already fragile state.

It is impossible to completely define the epidemiological and health services impacts of such human flows even in the future. The vulnerable situation of Syrian refugees could be only indirectly deducted from annual household surveys: for example, in 2018, 4,446 Syrian refugee households from 26 districts across the country were randomly visited, feeding the data on the Vulnerability Assessment of Syrian Refugees in Lebanon (VASyR) (UNHCR/UNICEF/WFP, 2018). This data may underestimate the overall load of the situation, or not being anymore representative of the situation due to the relighting of the tensions in Syria in October 2019.

In order to address this, efforts have been geared towards strengthening the local MoPH both centrally and peripherally, as well as the overall primary healthcare system. Recently in 2017, the MoPH has established a Health Information System to monitor health indicators and related outcomes necessary for future health planning and decision-making. The online system connects 75 Public Health Centres to the Primary Health Care Unit in the MoPH, ensuring the centralization of information and rapid transferring of data to the Ministry of Health (WHO, 2017).

3.4 The Case of Syria

The Syrian conflict started in March 2011, involving the government and a spectrum of anti-government factions including the so-called Islamic State - ISIS. Warring parties have proliferated, from additional jihadist groups, to Russian and US-led coalition forces. Since its beginning, the Syrian crisis claimed hundreds of thousands of lives and countless injuries among civilians. Aerial bombings and shelling rapidly became primary causes of direct deaths of civilians, calling into question the use of wide-area explosive weapons in urban areas (Guha-Sapir *et al.*, 2018). According to United States intelligence, Syria has had a stockpile of chemical weapons since 2012, and – according to the same source - over the past years both the Syrian government and ISIS have been responsible for chemical weapons attacks (Arms Control Association, 2019). In 2013, the United Nations called for an immediate investigation, since the government was suspected of using chemical weapons in an attack on civilians outside Damascus, where more than 1,300 people were killed, many of them women and children (CNN, 2013). The latest attack was reported in Douma, in April 2018, where the Organization for the Prohibition of Chemical Weapons (OPCW) concluded in its final report that a toxic chemical, likely chlorine, had been used (UN Security Council, 2019).

Just recently, in October 2019, Turkey launched an offensive into north-eastern Syria against the Kurdish forces who controlled the region. Images showed smoke rising with civilians fleeing towns. During the airstrike on the border town of Ras-al-Ayn, some civilians were reporting suspected signs of being exposed to chemical substances (phosphorus gas). The OPCW claimed to be aware of the situation in Syria and to be investigating the alleged use of chemical weapons (Independent, 2019). At the time we concluded this article, the chemical attack was not yet confirmed but the situation might have evolved.

The protracted conflict had a cumulative destructive effect on the economy, infrastructure, agricultural production, food systems, social institutions, as well as human resources. Syria has become one of the most dangerous places for healthcare providers, where hundreds of healthcare workers have been killed and / or tortured, and several health facilities deliberately destroyed (Fouad *et al.*, 2017). As a main result, the health system has been directly and indirectly impacted catastrophically, with supply lines interrupted and a general degradation of key services (The Syrian Centre for Policy Research, 2015). The large scale breakdown of health services led to a decrease in life expectancy and an increase in childhood mortality (Guha-Sapir *et al.*, 2018), that has obliterated the public health gains made in the past (Abbara *et al.*, 2015). Despite moderately high vaccination coverage rates in pre-conflict Syria (UNICER & WHO, 2012), recent reports of infectious disease outbreaks have become increasingly common. Today's reduced coverage rates are striking, if compared to 2010, a time in which more than 80% of the target age group was vaccinated (de Lima Pereira *et al.*, 2018). After having being considered for 15 years as a polio-free country, Syria reported a polio outbreak in 2013-2014, which also spread to neighboring countries (Ozaras *et al.*, 2016). The formal recognition of the outbreak prompted a multi-country regional response, with a variety of actors involved in immunization campaigns (WHO Regional Office for the Eastern Mediterranean, 2016).

The armed conflict has caused massive and continuous exoduses of Syrians: more than 5 million people are still displaced inside the country, with another five million living in neighboring countries, mainly Egypt, Iraq, Jordan, Lebanon, and Turkey (Operational Portal Refugee Situation, 2019). The majority of the refugees rely on humanitarian assistance to meet their basic needs. The health systems of the hosting countries have been challenged to respond to the diverse health needs of the refugees, while trying to preserve services for their own citizens. The need for emergency and basic health services, such as reproductive and maternal / child health, draws a disease burden profile consistent with that of middle-income countries (Akik *et al.*, 2019). High risk of epidemics in neighboring countries were registered (WHO

Regional Office for the Eastern Mediterranean, 2013), with increased rates of tuberculosis reported among Syrian refugees in Lebanon and Jordan.

While there has been some attention on the challenges of meeting health needs of Syrian refugees in neighboring countries, very little has been documented about the humanitarian challenges within Syria. It is estimated that over seven million people in the country are without access to basic healthcare (UNOCHA, 2016), but insufficient information is available about the effects of the conflict on the health of the population inside Syria (Ismail *et al.*, 2016). A recent World Bank study found – even if the results are not yet confirmed - that in Syria, more people may have died because of the breakdown of the health system than because of direct fatalities due to fighting (World Bank Group, 2017).

In order to monitor the health care in the country, in early 2013 the Syrian Ministry of Health and sector partners adapted a tool called HeRAMS (Health Resources and Services Availability Mapping System). The key information assessed the functionality status of the public health system, including health infrastructure, human resources, availability of health services, equipment, medicines at primary and secondary care level. HeRAMS has been developed to provide timely information, in order to support decision-making and coordination of health sector actors in emergencies, but can also be applied to post-emergencies, recovery and development contexts (WHO Regional Office for the Eastern Mediterranean, 2017).

4. DISCUSSION

After CBRNe events, especially during long-lasting conflicts, a country's situation is often characterized by a weakening of the health system, complicated also by the limited quantity and quality of human resources (Lanjouw *et al.*, 1999). The field-reports from Afghanistan, Iraq, Lebanon and Syria provide evidence of CBRNe conflict-related threats on the public health asset, exposing the existing systems to fragility, and difficulties in maintaining and strengthening them (Sharara & Kanj, 2014). Health structures collapsed, while many health professionals have been killed or forced to flee, causing a shortage of personnel. The loss of human resources and talents has been huge, while investments have been diverted from civilian to military facilities (Mokdad *et al.*, 2016). The breakdown of health services, and water and sanitation treatment plants, increased exposure of people to vulnerabilities, lack of investments in public health, as well as huge flux of refugees and displaced people have opened the door to disease outbreaks, even beyond borders. As an example of the impact of Syrian war to neighboring countries, Syria and Iraq experienced the reemergence of polio in areas declared polio-free before the conflicts (Arie, 2014), due to deep decline in health infrastructures and delivering devices (i.e., immunizations). The caseload of diseases among refugees and displaced people (especially in Iraq and Lebanon), posed new challenges for hosting government and humanitarian agencies in the provision of early assessment, health care, diagnostics, and medications.

Alongside the direct and relatively short-term causalities, long-term and potentially health devastating consequences stemmed also from the erosion of the states' ability to conduct health monitoring and surveillance, thus being not only unable to identify, prevent and treat adverse health conditions, but also to set up effective strategic plans. In these fragile states, health data are still mostly estimated by modeling techniques using other available variables and figures, often collected from neighboring countries or from countries with a similar health profile. Occasionally, data are deduced from surveys, censuses, household recalls for death, or United Nations estimates that account for migration. Frequently, data trends show discrepancies in case report numbers between government and non-government controlled areas, and interpretation is hampered by uncertainties over sentinel surveillance coverage and base population numbers (Ismail *et al.*, 2016). Uncertainty about population denominators (due to unknown numbers of killed people, limited capacity to monitor in- and out-flows, collapse of prewar statistical services, and outdated census figures) impedes meaningful analysis of health data (e.g., coverage indicators) and accurate service delivery planning (e.g., vaccination) (Diggle *et al.*, 2017). This condition can last even long after emergencies and CBRNe events, especially in war-torn countries, so that targeted health interventions and preparedness plans do not exist, or are not fully and timely implemented.

The rebuilding process includes a wide array of actions and actors (Rutherford & Saleh, 2019). Collecting, analyzing and interpreting data on the health of the population (epidemiological surveillance) is the

fundamental starting point to know its status and the hazards threatening it, in order to address its specific needs, thus providing timely and useful evidence, which is essential for effective decision making (Murray, 2009; Lopez & Setel, 2015). Indeed when talking about public health systems, one of the primary responsibilities of any government is to protect health throughout three key elements: prevention, early detection, and timely and effective response. Public health surveillance is the epidemiological foundation for modern public health (Bonita *et al.*, 2003), which has proven to have a central role in health policies planning and evaluation, thus being termed “the foundation of all public health practice” (Henderson, 2016). Investment and proper research towards post-events reconstruction is imperative for addressing healthcare problems and establishing an effective resilience (Rutherford & Saleh, 2019). A key requirement for effective health system development is the availability of reliable health indicators (Kruk *et al.*, 2010). Therefore, health monitoring systems providing useful data for epidemiological surveillance are essential to support local governments during the effective rebuilding of an efficient public health system. In addition, the epidemiological surveillance system will also act as an early warning system, which is extremely important especially for fragile states (Emberti Gialloreti *et al.*, 2020b). Only with rapid alerting of suspected cases of diseases can countries implement appropriate response measures to mitigate their negative impact. After CBRNe emergencies, as well as after each complex emergency, guidance for health interventions consistently highlights in fact the need for simple but effective health monitoring systems covering basic health information data of the population (i.e., mortality and morbidity data), health services delivery and response planning (UNHCR, 2007). Innovative strategies are needed to provide long-term strengthening of public health services and provision of health care access for the whole population, including refugees, displaced persons and minorities.

Nevertheless, a critical role is played by the strengthening of leadership and management capacities at all levels. Supporting capacity building and technical leadership should not be neglected and always be considered a key priority integrated into the humanitarian health response in emergency areas (Diggle *et al.*, 2017).

5. CONCLUSION

CBRNe events often leave a damaged health system behind. Building or re-building a public health system has epidemiological surveillance as a paramount basis for producing relevant statistics and access the health needs of the population in post-CBRNe events. This allows governments to support day-to-day health management, population’s health protection and promotion, while providing useful data for long-term planning and health policy development. Therefore, the recovery phase after CBRNe events, especially in war-torn countries, is a long process which requires inputs at all levels from multiple stakeholders. Coordinated actions offer an opportunity to set in place the foundations for nationwide governance and are the backbone for a post-conflict empowerment of the health system. Hitting those targets, especially in fragile states, serves as guide in planning future interventions and in strengthening the country’s health institutions, preventing deep impact consequences in case of further CBRNe events.

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