Main challenges in the control of zoonoses and related foodborne diseases in the South Mediterranean and Middle East region

Aristarchos Seimenis1* and Giorgio Battelli2

2Formerly Department of Veterinary Medical Sciences, Alma Mater Studiorum, University of Bologna, Italy.
*Corresponding author at: 25 Neapoleos st., 15310 Athens, Greece. Tel.: +30 6972712715, e-mail: seimenisaris@gmail.com.

Summary

In the South Mediterranean and Middle East region, interactions between humans, animals, and the surrounding environment are frequently close. This fact is mainly manifested in traditional farming settings (by sedentary, semi-sedentary, and nomadic communities) as well as where livestock intensification has been introduced. A combination of complex factors in these settings (e.g. challenges in country infrastructures and cross-sectoral collaboration/coordination, traditional habits, poor social information, etc.) contribute to the emergence and, occasionally, to the endemic pattern of zoonoses. The phenomenal growth of international travel and trade, population displacement, and unhygienic settlements has increased the speed and ease with which pathogens and vectors can cross continents and cause outbreaks and epidemics. Programmes for the prevention and control of zoonoses have been implemented in several countries in this region; however, the expected results have not always been realised. The conflicts and civil unrest affecting certain countries in this region during the last decade, together with the mass displacement of people seeking refuge, have resulted in serious epidemiological and social impacts. Zoonoses and related food-borne diseases are, indeed, a worldwide challenge, whose prevention and control mainly depend on the actions of national authorities. Once peace has been established in this region, authorities need to address the burden of these diseases through resource mobilisation, the implementation of international agencies’ technical guidance, and inter-country collaboration.

Keywords
Zoonoses, Control, Foodborne diseases, Middle East, Mediterranean.

Principali sfide nel controllo delle zoonosi e delle malattie correlate di origine alimentare nelle regioni del Sud-Mediterraneo e del Medio Oriente

Parole chiave
Zoonosi, Controllo, Malattie trasmesse da alimenti, Medio Oriente, Mediterraneo.

Riassunto

Nelle regioni del Sud-Mediterraneo e del Medio Oriente (SMMER) esiste una stretta interazione tra persone, animali e l’ambiente circostante. Questo avviene soprattutto dove il bestiame viene allevato tradizionalmente da parte di comunità stanziali, semistanziali o nomadi, ma anche dove è stato introdotto l’allevamento di tipo intensivo. Inoltre, un complesso di fattori critici (es. inefficienza delle infrastrutture del paese, di collaborazione/COORDINAMENTO intersettoriali, mentalità legata alle tradizioni, carenza nell’informazione della popolazione, ecc.) contribuisce all’emergenza e talvolta all’endemicità delle zoonosi. L’aumento straordinario dei viaggi e dei commerci internazionali, lo spostamento e la raccolta di popolazioni in luoghi igienicamente carenti hanno accresciuto la velocità e la facilità con la quale i patogeni e i loro vettori stanno attraversando i continenti, causando focolai di infezione, talvolta epidemici. Programmi di prevenzione e controllo delle zoonosi sono stati attivati in tutti i paesi dello SMMER, tuttavia senza i successi sperati. Conflitti e instabilità politico-sociali, che si sono manifestati in diversi paesi nell’ultimo decennio, con milioni di individui diventati migranti economici e rifugiati politici, stanno causando gravi conseguenze di carattere epidemiologico e sociale. Le zoonosi e le malattie correlate di origine alimentare rappresentano certamente una sfida a livello mondiale. La loro prevenzione e il loro controllo dipendono dalla ferma decisione e dalla capacità delle autorità nazionali competenti di ristabilire, prima di tutto, condizioni di pace e, in seguito, dalla volontà di combattere queste malattie, reperire risorse e rendere operanti il supporto tecnico e direttivo delle agenzie internazionali e la collaborazione tra paesi.

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Introduction

People have always depended on animals as sources of food, transport, labour, and companionship. However, countless species of animals are also sources of communicable diseases, which are transmitted through direct contact between humans and the domestic and wild animal reservoir, or indirectly through, for example, contaminated food, biological products, environment, and vectors. Such conditions are classically named zoonoses or zoonotic diseases.

For many years and in many countries zoonotic diseases have imposed a very heavy burden among people living and working in rural areas as well as in the crowded and unhygienic environments of most cities.

Zoonoses and related foodborne diseases (FBDs) are a progressive concern in the public health domain. The health and socio-economic impacts of these diseases have increasingly been documented in many countries: most notably, although not exclusively, in developing countries. Apart from causing human suffering, morbidity, and mortality, the diseases hamper agricultural production, decrease the availability of food, and create barriers to international trade, thus impairing national wealth and development (PAHO-WHO 2003, Maudlin et al. 2009, Bueno-Mari et al. 2015).

Reasons for zoonoses emergence, re-emergence, and spread

A number of factors have contributed to the expansion of the geographical distribution of zoonoses. These include: Increasing and largely unplanned urbanization, major population movements, new areas in food production, growing international trade in meat, milk, and other products of animal origin, the emergence of relatively easy and frequent travel, and tourism. This has occurred to the point that zoonoses are no longer confined to rural areas, but have gradually reached peri-urban and urban areas at a global scale (Mavroidi 2008, Maudlin et al. 2009, Tabbaa and Seimenis 2013, Bueno-Mari et al. 2015, Paveska 2015).

Interaction between humans and animals, the consumption of raw milk and fresh milk products, the intensification of animal production, illegal slaughtering, and inappropriate waste disposal, environmental degradation, and uncontrolled human population settlements – particularly in and around cities, often without adequate sanitary conditions – usually result in an increasing number of stray dogs and cats, rats, and arthropods, which may in turn transmit zoonotic diseases (e.g. rabies, leishmaniasis, echinococcosis, leptospirosis, etc.).

During the last decades, the alteration of ecological conditions has also played an important role in the emergence, re-emergence, and spread of zoonoses (Mavroidi 2008, Hassaimain et al., 2013, Seimenis 2008, Seimenis and Tabbaa 2014, Paveska 2015, Klaus et al. 2016. Conflicts, population displacements etc. represent additional further burdening factors (WHO-EMRO 2015, 2016).

The South Mediterranean and Middle East Region (SMMER)

The SMMER includes the following countries, all of which are members of the WHO-Eastern Mediterranean Regional Office: Afghanistan, Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, Yemen.

Animal farming, human population, and zoonoses

The livestock in the SMMER is mainly composed of cattle, sheep, goats, camels, and, in certain areas, buffaloes. Traditional herds and flocks are small and dispersed. The nomadic and semi-nomadic breeding of small ruminants is commonly found in this region. Flocks and herds of different species and health status may share the same environment, thus increasing the chances of transmission of zoonoses. Moreover, the animal population links the human population and its surrounding environment. This is particularly true in traditional farming settings practiced by sedentary, semi-sedentary, and nomadic communities, as well as where livestock intensification has been introduced (Greger 2007, OIE 2009, Sherman 2011, Paweka 2015, Roess 2015, Klaus et al. 2016).

Most of the human population in these areas share almost similar geoclimatic and epidemiological conditions with regard to zoonoses and related FBDs, as well as common traditional habits and behaviours. The above factors contribute to the perpetuation of conditions such as brucellosis, cystic echinococcosis, non-typhoidal salmonellosis, leishmaniasis, rabies, and zoonotic bovine tuberculosis (Battelli et al. 2002, Garguri et al. 2004, WHO (HQ-MZCP)/OIE 2008, FAO 2009, Ruiz Bostigo 2010, Dakkak 2010, Dean et al. 2014, FAO 2014a, Wernery 2014, Horton et al. 2015, Musallam et al. 2016).

A combination of additional factors contribute to sustaining the transmission of zoonoses at endemic level (sometimes even triggering epidemics), and prevent existing disease control programmes from achieving their objectives. Such factors include: poor infrastructure, lack of trained professionals, weak or absent inter-sectoral collaborations,

**Foodborne zoonoses**

In general, FBDs constitute a permanent problem in the whole SMMER. The WHO-Eastern Mediterranean Region has the third highest estimated burden of FBDs per population (the African and South-East Asia Regions being the first and the second, respectively). According to this evaluation, in SMMER, annual cases of foodborne zoonoses (FBZ) could represent 55-60% of the total cases of foodborne hazards (diarrheal and invasive infectious disease agents, helminths, chemical, and toxins). *Campylobacter*, *Escherichia coli*, and non-typhoidal *Salmonella enterica* infections have a high occurrence, while Cryptosporidiosis, giardiasis, listeriosis, toxoplasmosis, and trematode infections are present in most countries. The prevention and control of these conditions through safe food and water, and appropriate management of urban waste water, represents a major challenge (Collins and Wall 2004, FAO/WHO 2004, FAO/WHO 2005, WHO 2008, Hassaimain et al. 2013, Tajkarimi 2013, Idriss and El-Habbab 2014, WHO 2015a, WHO-EMRO 2016).

Non-typhoidal salmonellosis remains among the main causes of foodborne illness. It is known to be an important cause of severe diarrhea, mainly among children, but also in other population groups. It also creates serious economic problems in poultry production, which is considered the main source of human infection.

The importance of FBZ as a public health problem is often overlooked because their true incidents are difficult to quantify and the severity of their social and economic impacts are not always fully understood. In the SMMER, there is a scarcity of reliable information both on their burden among the human population and on sources of food contamination. For example, a survey on foodborne pathogens in Jordan indicates significant under-reporting and under-diagnosis of *Salmonella* and *Shigella* infections. Notably, it was estimated that for each person with a laboratory-confirmed diagnosis, there are 270 additional infected people in the community (FAO/WHO 2005, FAO/WHO 2006, WHO 2008, Gargouri et al. 2009, Krause and Hendrick 2011, Musaiger 2011, Hassaimain 2013, WHO 2015a).

Many factors contribute to the incidence and endemicity of FBZ in the SMMER region. Good manufacturing practices and quality assurance systems (Hazard Analysis Critical Control Points) have only recently been introduced into the food production and catering sectors. Nevertheless, street food vending is present in most countries in the region, and often vendors have little or no formal education in food handling practices. An additional factor is the lack of knowledge for issues relating to the importance of the hygienic living conditions, food handling, and food safety, which results in large consumption of raw milk, fresh milk products, and uncooked salads, for example (FAO/WHO 2004, FAO/WHO 2005, WHO 2008, Krause and Hendrick 2011, Musaiger 2011, Hassaimain et al. 2013, Takjarimi et al. 2013, WHO 2015a).

**Emerging and re-emerging zoonoses**

In spite of the many considerable achievements made in the control of communicable diseases in recent decades, emerging and re-emerging zoonotic diseases have remained one of the leading causes of morbidity and mortality in human populations. These diseases continue to retain the attention of the scientific community and public health officials around the world.

The phenomenal growth of international travel and trade has vastly increased the speed and ease with which pathogens, including drug-resistant strains and vectors, can cross continents and cause outbreaks and epidemics. The SMMER is not an exception. In addition to the contributing factors detailed above and the endemicity of certain zoonoses to the region, the close interaction of animals (both domestic and wildlife), animal products, and humans creates an environment that favours the emergence, re-emergence, and perpetuation of these types of infections (Greger 2007, WHO 2007, Chomel 2008, Seimenis 2008, FAO 2009, Sherman 2011, Molyneux et al. 2011, FAO 2011, Hotez et al. 2012, Wang and Craumen 2014, Wernery 2014, Wiethoelter et al. 2015, Bueno-Mari et al. 2015, Paweska 2015, Roess et al. 2015, Klaus et al. 2016, WHO-EMRO 2016). Some examples of emerging zoonoses are the following:


Highly pathogenic avian Influenza (HPAI-H5N1) appeared in Egypt in December 2003, and became endemic. Between then and September 2016, a total...
of 356 laboratory confirmed cases of human infection were reported to the World Health Organization (WHO), and in 2016 two fatal cases occurred in children exposed to domestic poultry. Infections in poultry were recently detected in Lebanon and Iraq. Iran, Jordan, and Syria are considered at high risk for the introduction of HPAI-H5N1 from these countries as a result of the movement of live poultry, poultry-related products, and the migration of wild birds (Hotez et al. 2012, McDowell and Rafati 2014, Wang and Craumen 2014, FAO 2016, WHO 2017).

Middle East respiratory syndrome coronavirus (MERS-CoV) was first identified in Saudi Arabia in 2012 and since then many countries within SMMER have reported human cases. It is believed that humans can be infected with MERS-CoV through direct or indirect contact with infected dromedary camels. Strains of the virus were identified in camels in several countries, including Egypt, Oman, Qatar, and Saudi Arabia (Wernery 2014, Poletto et al. 2014, Roess et al. 2015, Alraddadi 2016, Mohd et al. 2016, WHO 2016, Zumla et al. 2016, Han et al. 2016).

Crimean-Congo haemorrhagic fever (CCHF) is one of the rapidly emerging viral haemorrhagic fevers. Sporadic human cases and outbreaks were reported from several countries in the WHO-Eastern Mediterranean Region. In 2014, Oman reported 18 cases of CCHF, including one death nearly 15 years after the first case was detected in the country. Nosocomial outbreaks were reported in Afghanistan, Iran, Iraq, and Saudi Arabia, which resulted in high mortality among hospital staff (Hotez et al. 2012, McDowell and Rafati 2014, Wang and Craumen 2014, WHO 2015b).

Other emerging zoonoses affecting SMMER include West Nile fever, reported in the early 1950s in Egypt; Alkhurma haemorrhagic fever, first reported in 1995 in Saudi Arabia; and, among emerging FBDs, Shiga toxin-producing Escherichia coli infection, first described in 1982 (Mohammadi et al. 2013, Sabatino et al. 2014, CDC 2014, Garbaj et al. 2016).

Regional activities on the prevention and control of zoonoses and related FBDs

SMMER countries have made several efforts to reduce the prevalence of some major zoonoses. Programmes to control such diseases have been implemented in most countries and/or zones by the responsible governmental agencies or by non-governmental organizations. Additional technical support is often provided by international organizations (IOs) such as the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE), and WHO, although mainly on an ad-hoc basis, and usually in response to an emergency situation.


In this context it should be noted that besides structural weaknesses, difficulties challenges with programme implementation also exist. For example, identifying, vaccinating, and monitoring most infected sheep and goats in brucellosis’ infected flocks as well as controlling their movements, is difficult considering the types of nomadic or semi-nomadic farming that are prevalent in the region. Such situations create additional impediments to meeting programme targets for preventing and controlling zoonoses. It should furthermore be noted that successful prevention and control strategies rely on a thorough understanding of local and regional differences in animal husbandry practices, social customs, infrastructures, and epidemiological patterns. Additional impediments towards progress are represented by the conflicts, civil unrests, and population displacements in certain countries of the region (Barcelona Process 2000, FAO/WHO 2005, FAO/WHO 2006, WHO 2007, Tabbbaa 2008, OIE 2009, FAO 2011, Molyneux et al. 2011, Roess et al. 2015, Klaus et al. 2016, Zinsstag et al. 2016, Mokdad Ali et al. 2016, WHO-EMRO 2016).

Social and economic impacts of zoonoses and related FBDs

The existing structural, social, breeding, geoclimatic, educational, and financial handicaps are conducting to an almost stationary epidemiological situation of zoonoses and related FBDs in certain countries or zones of the SMMER. Such conditions create progressive social and economic impacts that could be summarized as follows (FAO/WHO 2005, Seimenis et al. 2006, FAO 2009, Sherman 2011, Dean et al. 2012, Horton et al. 2015, WHO 2015a, Klaus et al. 2016, Mokdad Ali et al. 2016):

Social and economic impacts in humans:

- medical fees: costs of diagnosis, hospitalisation, nursing, medication;
- absence from work, therefore reduced income and productivity;
- deterioration of quality of life;
- social consequences of disability;
• abandonment of farming or agricultural activities by affected or at-risk persons.

Economic impacts in livestock:
• reduced yield and quality of animal production (meat, milk, wool, eggs, labour, etc.);
• reduced birth rate and infertility;
• reduced adult livestock replacement and availability of sufficient meat for human consumption;
• condemnation of organs and costs for destruction of viscera and/or carcasses in some cases;
• lowered price of animals, milk, and dairy products;
• ban on exportation and national movement.

Administrative costs:
• costs from delayed economic growth at the animal breeding level;
• government compensations for positive animal slaughtering and replacement;
• costs for increased laboratory surveys and diagnosis;
• costs for medical and veterinary personnel training associated with prevention and control activities;
• costs for intensified professional training and public health education programmes, including those associated with using mass media.

The way forward

Zoonoses and related FBDs represent a very important public health problem. However, many aspects and factors involved in their prevention and control cannot be addressed by the health sector alone. Success in reducing the public health burden of zoonotic diseases depends on collaborations between medical and veterinary sectors, especially inasmuch as those collaborations result in information exchange, laboratory diagnosis, surveillance, staff training, and community awareness. There is also need for national programmes to mobilize and commit the necessary resources. Inter-sectoral collaboration and coordination are fundamental to controlling zoonoses and FBDs. However, the processes involved in planning and implementing inter-sectoral actions are complex. Each country in the SMMER should therefore develop its own strategy and approaches (Shimshony and Economides 2006, Zinsstag 2006, Zinsstag et al. 2007, Mantovani 2008, WHO 2008, Tabbaa 2008, Molyneux et al. 2011, WHO 2011, Idriss et al. 2014, WHO/OIE/WB 2014, Stringer 2014, Mwangi et al. 2016).

A primary challenge to the effective implementation of zoonoses prevention and control programmes is the establishment of effective public health and animal health epidemiological surveillance systems with well-trained staff. Sectors such as health, consumer protection, animal health, agriculture, and the environment must be aware of – and involved in – cooperative efforts in this domain. It is well-known that the main function of epidemiological surveillance systems for zoonoses and related FBDs is to provide the information required to select appropriate interventions. Analysis of surveillance data makes it possible to identify operational options, their cost, and their benefits. Active and integrated surveillance systems should therefore be adopted by all countries in order to ensure that a high quality of data is collected (Shimshony and Economides 2006, WHO 2007, Tabbaa 2008, Chomel 2008, Seimenis 2010, FAO 2011, WHO 2011, FAO 2014b, Holloway et al. 2015, Zinsstag et al. 2016).

Outbreaks often occur in areas far from health care centres and services; therefore, reliable relevant data on distribution, incidence, prevalence, and mortality are scarce. This is partly due to a lack of appropriate diagnostic tools suitable to such conditions. Diagnosing and detecting pathogens are basic requirements for the prevention and control of any communicable disease; therefore, national programmes need to strengthen capacities within laboratories, so that they can assume this responsibility (Barcellona Process 2000, FAO 2005, WHO 2007, FAO 2011, WHO 2011, Kock et al. 2012, WHO/OIE/WB 2014).

Considering the complexity of factors involved in the emergence, re-emergence, and/or endemicity of zoonoses and related FBDs, national control programmes should be developed with long-term objectives that include active collaborations with IOs such as the FAO, OIE, and WHO, whose mandates include providing technical advice and assistance and, where appropriate, resource mobilisation. Close collaboration and information exchange is required particularly among countries that share borders. Collaborations should be based on legal agreements, and should involve public health and animal health sectors, as well as other relevant professionals. Raising awareness among decision-makers and policy-makers on the social and economic burden of zoonoses in humans and animals will enhance commitment and financial support towards the achievement of the targets set by national control programmes (Zinsstag 2006, WHO/FAO/OIE 2008, WHO 2010, Hotez and Savioli 2012, WHO/OIE/WB 2014).
**Discussion**

In the SMMER, several zoonoses and related FBDs are endemic and others are emerging or re-emerging. They represent a permanent threat to human and animal populations, but also lead to significant economic loss by reducing the availability of animal products and by creating barriers to the international trade of live animals and their products (FAO/WHO 2006, Shimshony and Economides 2006, Seimenis 2008, FAO 2009, Sherman 2011, Wang and Craumen 2014, Paweska 2015).

Lowering the burden of FBDs and making food safer and suitable for national and international trade depends on establishing effective surveillance mechanisms and on improving production, processing, and food control systems compliant with international standards. Strengthening public health education systems and improving the hygiene of feeding conditions is another relevant set of priorities for social and economic development (Collins and Wall 2004, Krause and Hendrick 2011, Musaiger 2011, Molyneux et al. 2011, Hassaimain et al. 2013, Tajkarimi 2013, Idriss and El-Habab 2014, WHO 2015, WHO-EMRO 2016).

The availability of safe food improves public health and is also a basic human right. Poor and marginalised populations are moreover more susceptible to ill health because of unsafe food and water. Safe food therefore constitutes an important platform for development and poverty alleviation (Collins and Wall 2004, FAO/WHO 2004, FAO/WHO 2005, WHO 2008, Molyneux et al. 2011, Musaiger 2011, Tajkarimi et al. 2013, Idriss et al. 2014).


Several determinants can lead to development-hampering conditions. They include: socio-political and socio-cultural behaviours such as lack of cross-sectoral coordination, vector ecology, occupational activities, natural disasters, uncontrolled urbanisation, indiscriminate use of insecticides, weak national infrastructures, lack of public health education and community awareness. Such conditions entrap the most vulnerable populations. These factors are among the most critical determinants affecting the health of individuals and societies; they also increase vulnerability to diseases by limiting access to quality health care, safe and nutritious food, and adequate housing. National animal health services should not restrict their activities to safeguarding livestock. Rather, their aim should be to protect public health. Equally, public health services should not limit their activities to diagnosing and treating patients, but rather should aim to identify the sources of human zoonotic infection and inform veterinary services, thus enabling them to take necessary further actions. It should be clearly understood that animal health and human health are inextricably linked and that both sectors share common goals of protecting, promoting, and improving the health, wellbeing, and economic development of the community (Kahn et al. 2007, Zinsstag et al. 2007, WHO/FAO/OIE 2008, Mantovani 2008, FAO 2009, Molyneux et al. 2011, Stringer 2014, WHO/OIE 2014, Zinsstag et al. 2016, Mwangi et al. 2016).


Another important factor contributing to long-term surveillance, prevention, and control programmes, is capacity building, a basic strategy needed to build the technical capacity of staff in all SMMER countries. The training of staff from multiple sectors provides an environment to share and consolidate knowledge and, moreover, can help establish necessary intersectoral relationships. The adoption of a coherent staff training strategy leads to key outputs in the medium and long term (WHO 2007, Seimenis 2010, FAO 2011, Idriss et al. 2014, Holloway et al. 2015).

The following key achievements can be attained through capacity building:

i. more and better qualified professionals and community-based workers in public health, animal health, and related sectors;

ii. better understanding of the importance of efficient early-warning systems and of the exchange of information through intersectoral collaboration and coordination;

iii. expertise in country- and regional-level contingency and preparedness plans, including horizontal inter-communication systems;

iv. promotion of appropriate legislative and financial support to zoonotic and FBDs programmes and their management;
v. enhanced support from major IOs to encourage and support countries in the capacity development of their public health, animal health and related sectors;

In conclusion, the implementation of a coherent and comprehensive capacity-building strategy is expected to have a beneficial and long-lasting impact on country development as well as specific control and prevention programmes.

There is no doubt that the prevention and control of major zoonoses and related FBDs depend on the commitment of national authorities to address the burden of these diseases, mobilise resources in different sectors, and establish and coordinate intersectoral collaborations, especially between public health and animal health services, in association with education and community-awareness programmes. Close and legally ratified collaboration between neighbouring countries is an additional important parameter. These comprehensive approaches can, with the support of international technical collaborations, contribute to the alleviation of human suffering as well as mitigate the social and economic burden associated with this group of diseases (WHO 2006, Zinsstag 2006, WHO 2007, WHO/FAO/OIE 2008, WHO 2010, Seimenis 2010, FAO 2011, Idriss et al. 2014, Stringer 2014, WHO/OIE/WB 2014, Holloway et al. 2015, Mwangi et al. 2016).

In recent years, conflicts and civil unrests in certain countries of the SMMER have displaced millions of people. Health services and facilities have been disrupted, medical supplies are becoming rare, and access to healthcare is dwindling. As a result, prevention and control programmes for communicable diseases have been affected. Detecting and responding to outbreaks has deteriorated, while projecting future needs has become a challenge (WHO-EMRO 2015, Mokdad Ali et al. 2016, WHO-EMRO 2016).

In conclusion, the control of zoonoses, related FBDs, and communicable diseases is a world-wide challenge for governments, regional and local administrations, public and animal health sectors, scientific institutions, IOs, and affected communities. The first step to addressing this challenge in the SMMER is to reestablish stability throughout the region. This is, for the time being, the absolute priority and the most necessary condition for gradual social and financial development and the reduction of population displacements and its effects. Following this, only the coordinated and consistent involvement of relevant parties would open the way for effectively addressing the burden of zoonotic diseases in this region.

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