Research on the Multisectoral Impact of Infectious Diseases on the Economy

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Author’s contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The purpose of the work is to consider the features of the multidimensional impact of the consequences of the spread of infectious diseases on the economic development of countries. The author concludes that the process of public health exposure to regional or global new and endemic infectious diseases may have broader socio-economic consequences that are often not taken into account when assessing risk or impact. With the spread of international travel and trade, such events can cause economic shocks that go far beyond the traditional health sectors and the original geographical range of the pathogen. Intensive economic specialization and a broader division of labor, accompanied by expanding markets and increasing economic globalization, increase the risk of people coming into contact with sources that contribute to highly contagious diseases such as influenza and COVID-19. The adverse economic consequences of new forms or types of these diseases can be serious, taking into account the high degree of interdependence of economic activities in the modern economy. For example, the absence of workers from work due to such infections or the risks of these infections can disrupt production at the workplace level. Also, supply chains can be disrupted or disrupted by these pandemics, and in addition, they usually have a negative impact on aggregate

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demand for goods. This is evidenced by the COVID-19 outbreak, which led to a serious global economic depression. The occurrence and consequences of epidemics and pandemics depend on the nature and stages of economic development. The economic and social structure of modern society contributes to the transmission of diseases that depend on human contact or presence, especially those that are caused by airborne microbes or persist on commonly used surfaces. The study concluded that public and private stakeholders at the local, national and international levels should work together to address the economic consequences of infectious diseases, to provide informed systems and risk and impact analysis, and to promote cost-sharing strategies for prevention and preparedness where possible, and to evaluate optimal intervention strategies when necessary. Developments related to infectious diseases in today’s globalized world require increased responsibility for preserving people’s health and economic security.

Keywords: Infectious diseases; sectors of the economy; COVID-19; pandemic; devaluation; crisis.

1. INTRODUCTION

Health disasters such as the Ebola virus disease epidemic in West Africa, the Middle East Respiratory Syndrome (MERS) outbreak in the Republic of Korea, and the growing number of antimicrobial-resistant pathogens have spurred investment in global health security [1]. As global health works to strengthen national systems to avoid the international spread of diseases, policymakers are increasingly recognizing that biological threats not only affect global health, but also cause widespread socio-economic upheaval, followed or preceded by the main institutions’ failure, as described by Polyakova et al. [2].

Comprehensive economic assessments can provide a multisectoral translational understanding of the costs of diseases beyond traditional health-focused approaches that only consider cases, direct medical costs, and public health functions and measures.

Health is the foundation of a thriving and productive society, while fear and disease can suppress production, consumption, recreation, travel, and overall well-being. Although non-health sectors are often considered in the context of negative external factors that lead to disease, the potential consequences they face as a result of events require their participation in the search for multisectoral solutions to reduce disease risks and manage them [3].

In a broad sense, the far-reaching effects of pandemics are parallel to other disasters. For example, the Ebola epidemic in West Africa has shown serious and unforeseen economic losses associated with the emergence of a new infectious disease. From 2013 to 2014, gross domestic product (GDP) growth in Liberia declined from 8.7% to 0.7% due to Ebola and lower commodity prices, while GDP growth in Sierra Leone (excluding iron ore) declined from 5.3% to 0.8%. GDP growth in Guinea in 2015, projected at 4%, fell to 0.1%. In all three countries, government revenues declined everywhere, including direct taxes on companies, VAT receipts, and indirect taxes [4]. In addition, a decline in the confidence of private and foreign investors led to a funding shortfall of more than $600 million over two years. These impacts affect many sectors and undoubtedly have long-term consequences, including consequences for insurers and reinsurers (for example, for health, life), as well as for overall business continuity due to lack of performance during illness, and markets are emerging for pandemic risk insurance (for example, the world Bank’s pandemic emergency financing mechanism, a parametric insurance mechanism designed to ensure rapid disbursement of funds in emergencies [5].

In the recent period, the COVID-19 pandemic has had a sharply negative impact on the economic development of all countries of the world, which has brought a number of countries to the brink of financial disaster.

In order to avoid such a global impact of infectious catastrophes on the economic development of countries in the future, a deeper assessment of the impact of epidemics on the economy is necessary (that is, to determine macroeconomic trends towards the general equilibrium model, and not the impact on only one sector or market) [6]. A number of examples illustrating the breadth of the impact of recent epidemics should be considered to demonstrate that a society-wide approach is warranted to reduce the risk of infectious diseases.
Increased participation outside the health sector can help shape the direction of initiatives such as the global readiness monitoring Council, jointly launched by the World Bank and the world health organization in 2018 to monitor readiness to respond to pandemics and other health emergencies [7].

The aim of this work is to study the multidimensional impact of infectious diseases on the economy.

2. MATERIALS AND METHODS

The traditional scope for assessing the economic impact of diseases in humans has often been limited to basic direct costs (health care) and limited indirect losses (for example, lost wages and informal health care costs such as patient transportation). The burden of the disease can be reflected in health indicators (for example, the number of deaths or disability-adjusted years of life) [8]. Alternatively, one could apply the approach suggested by Kolmakov & Polyakova [9] to measure the indirect impact of the pandemic-driven expenditure on households' prosperity. While this limited amount of analysis is of great importance to the medical community, it is becoming increasingly clear that it does not provide a comprehensive picture of the economic impact of disease-related events, including infection prevention activities, in order to inform decision-making by a wider range of stakeholders and to engage in broader economic development programs.

The direct and indirect economic consequences of disease-related events are affected by disease preparation and prevention (risk-reducing methods), the event itself (for example, business continuity, supply chain disruption, trade and travel bans, behavior aimed at preventing infection of the population), and the consequences of the event (for example, long-term job loss, permanently closed markets or farms, long-term stigmas associated with specific animal products, consequences of losing education in childhood or orphanhood, etc.) [10].

In 2016, the second group of experts on cost-effectiveness in health and medicine emphasized the importance of applying a social perspective that goes beyond the health sector alone when considering the economic consequences of diseases as well as potential interventions [11]. Similarly, the world health organization (WHO) has proposed an economic impact guide as a framework within which to calculate the broader economic impact of diseases, and a proposed framework for analyzing the economic consequences of biological threats has been developed that explores broader consequences, including human behavior, the rate of resilience, and the dynamics of the "fear factor" that can cause irrational behavior aimed at preventing diseases [12]. This is preceded by extensive work by the veterinary sector, which views diseases as a problem that goes beyond the veterinary sector, emphasizing the need to assess the economic impact across the system, including also the cost of spending and the response to the disease.

The world Bank reported significant costs associated with diseases that occur at the intersection of humans, animals and the environment and require a "National health" approach with a high global return on investment in prevention by strengthening veterinary and human health capacities [13]. Applying multisectoral approaches to disease risk reduction and management can provide information about the possible economic outcomes (positive or negative) that can occur in any sector(s) as a result of various prevention and control strategies.

The paper considers cases when the indirect impact of infectious diseases was significant. Although such impacts have rarely been evaluated to date, the recognition of non-traditional stakeholders in the analysis of biological threat impacts supports their investment and participation in risk assessment, readiness, and / or intervention efforts. In particular, they can help inform stakeholders for inclusion in multisectoral national health safety action plans and similar budget processes involving ministries of finance and legislative bodies that can allocate resources to optimize "whole-of-society" outcomes [14].

3. RESULTS

Let's look at the examples of multisectoral impact of infectious disease outbreaks. Objects affected by outbreaks of infectious diseases are shown in Fig. 1.

3.1 The Health Care Sector

The impact of infectious disease outbreaks on the health sector is often the easiest to assess, or at least to calculate in hindsight. However, for new or newly emerging pathogens with
Unexpected clinical outcomes, forecasts can be difficult, and cost estimates are often limited to short-term medical costs, health burden, or mortality. For example, although typical Zika virus infections without consequences are unlikely to result in a significant burden, the manifestation of the disease in infants can have extensive consequences [15]. Not only direct medical costs are expected to increase during pregnancy, but also postpartum direct and indirect costs - especially given the implied long-term extensive care needed for these children as they grow. Researchers conservatively estimated the direct lifetime medical costs associated with the effects of microcephaly at US $ 179,760, and the cost per case of Gillian-Barre syndrome, a rare outcome of Zika cases (approximately 1%), in the US is at US $ 56,863 [15].

According to the authors, the cost of maintaining the health of children with microcephaly throughout their lives can reach 10 million US dollars each. These estimates will vary by country and do not include indirect costs such as specialized child care, loss of parental productivity, psychological damage to families with children with microcephaly or reduced child productivity when they become adults, and support services needed for that person throughout their life. It is estimated that the Zika virus epidemic cost Latin America and the Caribbean $ 7-18 billion between 2015 and 2017 alone [16].

As a result of the 2013-2015 Ebola crisis, there were at least 28,616 suspected cases and 11,310 confirmed deaths in West Africa. By comparison, there were 2,427 cases and 1,597 deaths in all other known Ebola outbreaks combined. The scale and depth of the crisis has been compounded by poor health systems in the countries affected. The outbreak resulted in 881 infections of health workers themselves (513 deaths) [17].

All health personnel declined by 8% in Liberia and 23% in Sierra Leone; this loss of health services resulted in approximately 10,600 additional deaths due to lack of treatment in Guinea, Liberia, and Sierra Leone (1,091 deaths from HIV, 2,714 deaths from tuberculosis, and 6,818 deaths from malaria).

In addition, the number of prenatal consultations has decreased, the number of births outside hospitals has increased (in Sierra Leone, the number of births in hospitals and clinics has decreased by 30%), child vaccination coverage has decreased by 30% during the outbreak, and child mortality from rubella and other vaccines has increased.

### 3.2 The Agricultural Sector

Given that 60% of all human infectious pathogens originate from animals, the agricultural industries involved in zoonotic outbreaks often suffer significant economic consequences that are underestimated. Fifty percent of the livestock losses reported by the world organization for animal health (OIE), the international organization for setting standards for livestock diseases, are caused by zoones, and zoonoses have a much higher percentage of animal slaughter (43% of livestock losses), as part of the utilization for disease control compared to non-zoonotic phenomena (6% of livestock losses) [18].

However, the incentive for the agricultural sector (such as livestock) to invest in the prevention of infectious diseases often correlates with the economic significance of the industry for its overall national GDP. For example, in the United States, where net meat exports account for about 12% of production, investment in animal health infrastructure is a priority [19].

<table>
<thead>
<tr>
<th>Objects affected by outbreaks of infectious diseases</th>
<th>Health care sector</th>
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<tr>
<td>Aricultural sector</td>
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<td>Tourism and travelling</td>
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<td>Trade and retail trade</td>
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<td>Environment</td>
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<td>Others</td>
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**Fig. 1.** Objects of exposure to infectious disease outbreaks
However, many developing countries that participate in agricultural trade have competing priorities that lead to less investment in infrastructure and animal health protection, and therefore may not apply adequate biosecurity measures. The latter could become a significant factor of investment appeal, as Pavlyuk et al. [20] see it, especially for the distressed or underperforming regions.

After Saudi Arabia and Yemen were hit by the Rift Valley virus, Arab countries banned the import of alive animals from at least nine African countries in 2000, which led to the complete collapse of the Somali livestock market.

Ninety percent of Somalia's total revenue came from livestock exports, and the ban resulted in the loss of more than 75% of exports and US $300 million. This caused social and financial instability, loss of livelihood and food security, and ultimately instability of the Somali government with a 25-35% reduction in GDP [21].

The costs of infectious disease outbreaks for the agricultural sector are often measured only by the cost of slaughtered livestock, while the broader long-term effects remain underestimated. During the Nipah virus outbreak in Malaysia in 1998 (which resulted in 283 cases of viral encephalitis and 109 deaths) the Malaysian government paid $97 million in compensation for 1.1 million pigs killed because of the outbreak. But in addition, these impacts resulted in additional indirect costs of $229 million as lost tax revenue for the government and losses in international trade, as well as costs of $136 million for the control program for biosecurity and animal slaughter enterprises [22].

Pork consumption and exports remained unchanged over the long term (decreased 80% during the outbreak and down the remaining 30% after the outbreak). The unmeasured economic impact of this outbreak in Malaysia continues to this day. The pig production in the hard-hit areas collapsed, forcing many pig farmers to try to switch jobs for which they had no training or education. These people experienced the effects of long-term unemployment or underemployment, and they were unable to achieve their former economic status, which also affected many local businesses that thrived thanks to them.

In the case of the H1N1 pandemic flu in Mexico, the simple perception of risk by the public led to costly consequences for the country's pig production; exports of chilled and fresh pork declined sharply (for example, by more than 60% to Japan), resulting in the country's pork trade deficit of $27 million by the end of 2009 [23].

### 3.3 Tourism and Travelling

During the SARS outbreak in 2003, the number of tourists in Hong Kong dropped by 68% just two months after the WHO issued an epidemic warning [24].

Asia-Pacific carriers lost $6 billion in revenue, while North American airlines lost another $1 billion. Tourism in Singapore has fallen by more than 70%, with Singapore Airlines sending 6,600 flight employees on unpaid leave. The effects were keenly felt at the local level. For example, the attendance of the Chinese trade fair in Guangzhou was 12% compared to the previous year [25].

In South Korea, where the introduction of MERS caused a brief outbreak in 2015, the number of foreign visitors fell by 41% in mid-summer compared to the same month last year. Only a month later, the number of visitors decreased by another 60%. The Korean government lost $10 billion, and in the years that followed it had to run expensive tourism campaigns to encourage travelers to visit the country. Similarly, the Saudi tourism industry has suffered approximately $5 billion a year due to travel restrictions related to MERS [25].

As a result, Mexico's tourism industry, its largest service sector, was affected by the H1N1 flu by 2.8 billion US dollars, resulting in a five-month period due to fears of infection, the potential number of tourists decreased by 1 million [26].

The Zika virus has shown similar trends in restricting travel for consumers nervous about infection. Concerns and travel warnings in the affected regions of the world provide a summary. Even limited travel recommendations in the popular tourist area of Miami, Florida, USA, caused a political and economic negative reaction, with businesses reportedly losing 50-60% of revenue. If the virus continues to spread in countries where tourism is a key component of GDP, such as the Caribbean, the economic impact of the disease on the tourism industry is likely to increase significantly.
3.4 Trade and Retail Trade

After killing at least 800 people and infecting 8,000, the total global economic damage from SARS is estimated at about $40 billion. The Chinese Bureau of statistics reported a 0.8% decrease in GDP in 2003, mainly due to losses in tourism, travel, hotel, restaurant and retail. Much of this impact was caused by consumer concerns, given the ease of transmission of the virus in public places [27].

Hong Kong's GDP fell by 2.6%. International transport companies such as FedEx and airport stores such as Estée Lauder were affected, causing economic consequences around the world. Transport restrictions and cancellations have affected multinational industries such as oil, for which demand has fallen by 300,000 barrels per day in Asia [28].

The broader economic impact of the Nipah outbreak in Malaysia in 1998 was estimated at $582 million. The losses affected sectors indirectly related to pig production (for example, in the feed industry, which supplied pig feed, production decreased by $15 million).

Approximately 618 homes, 111 stores, schools, and banks were evacuated, and as it was estimated 36,000 people lost their jobs not only due to pig farming, but also due to a wide range of economic activities such as utilities and the real estate industry (which lost us $1.1 million) [29].

During the MERS outbreak in South Korea, public fear of infection and an overreaction by the government led to the closure of many public events and the suppression of daily activities. Housing and food production declined by 10% compared to the previous year; entertainment and leisure production also fell by 8.6%, while publishing, communications and information sectors fell by 6.3%.

Transportation and storage fell by 2.4%, wholesale and retail trade fell by 1.6%, and electricity and air conditioning fell by 0.9%. However, the market reaction indicated a change in behavior due to avoiding public settings: South Korea's largest market chain, E-Mart Co Ltd. reported that online sales increased by 63%, and for the second largest chain, Homeplus, online sales increased by 50% in early June due to consumers avoiding regular stores [30].

Meanwhile, industries with a high proportion of temporary jobs (such as the restaurant, hotel and leisure sectors), which also tend to be disproportionately affected by outbreaks, were significantly affected, resulting in labor losses. South Korean exports were also affected: in the second quarter of 2015, the economy grew by just 0.3%; the lowest in six years.

3.5 The Impact on the Environment

Since environmental resources and services are usually considered non-marketable goods, damage to valuable natural resources, loss of wildlife populations, and environmental pollution are often overlooked in economic assessments of disease-related events. Local demand for natural resources may increase during a socio-economic and stability crisis, resulting in increased wildlife extraction and illegal use of protected land; enforcement of environmental protection policies may decrease when the government is overburdened with other burdens.

For example, quarantine and travel restrictions and their enforcement during the Ebola outbreak in West Africa led to illegal poaching, logging, and mining, and negatively affected achievements in protecting watersheds, forests, and animal sanctuaries, which negated earlier efforts to achieve the Millennium development Goal related to environmental protection [31].

During H5N1 flu outbreaks, national authorities culled wild birds, closed protected wetlands, and destroyed waterfowl habitats in a misguided attempt to stop the virus from spreading.

Economic damage from environmental impacts is rarely measured due to poor assessment of ecosystem services and other natural resources; however, the focus on environmental value, at least for individual ecosystem services (such as pollination), has advanced over the past two decades through initiatives such as "Ecosystem Economics and biodiversity". However, their integration into decision-making in the health sector remains extremely limited.

3.6 Other Impacts

Although morbidity and mortality values may indicate the severity of the impact of the disease on the population, they do not provide an estimate of the full impact of reduced productivity as a result of the disease on the individual, their household, or their community. For example, the
impact may include psychological, educational, or professional losses to the individual consumer and household. Not only has the unusually high death toll from the Ebola outbreak in West Africa increased the social and economic impact on households, but it has also curbed growth, reduced productivity and wages due to inability to work or fear of infection, increased poverty and food insecurity, lost jobs, and lost education.

The extent and type of economic impact of households is often (though not exclusively) associated with the most affected population group. With regard to Ebola, the 15-44 age group, which includes people in the labor market and parents of young children, accounted for 57% of all cases of infection, which explains why the impact on economic activity, poverty, and food security was so significant [32].

Between 60% and 70% of households reported that their incomes fell significantly during the outbreak; household consumption declined and the prevalence of malnutrition increased. In addition, some 16,000 children have lost their parents to Ebola, leaving them orphaned, needing long-term care from relatives or other means. In addition, it is believed that the closure of schools, which resulted in the loss of education for more than 33 weeks, exposed children to several types of abuse (including sexual exploitation and violence against girls) with long-term consequences, such as emotional trauma, reduced quality of education, and unwanted pregnancy.

Military personnel were brought in to perform normal public security duties to enforce quarantine facilities, and they were not trained for this task. They are only partial examples of ripple effects at the individual and household level that can affect the public and private sectors in countless short-and long-term ways.

3.7 The Impact of the Pandemic COVID-19 on the Global Economy

Increased economic specialization and a broader division of labor, accompanied by expanding markets and increasing economic globalization, increase the risk of people coming into contact with sources that contribute to highly contagious diseases such as influenza and COVID-19. The adverse economic consequences of new forms or types of these diseases can be serious, given the high degree of interdependence of economic activities in the modern economy. For example, the absence of workers from work due to such infections or the risks of these infections can disrupt production at the workplace level. Also, supply chains can be disrupted by these pandemics, and in addition, they usually have a negative impact on aggregate demand for goods. This is evidenced by the COVID-19 outbreak, which led to a serious global economic depression [33].

Most global pandemics significantly reduce global economic output and increase unemployment. In the case of COVID-19, government measures to prevent the spread of the disease and deaths from it have significantly reduced employment and economic activity worldwide. With unemployment rising and aggregate economic activity falling as social restrictions aimed at reducing the number of COVID-19 cases become stricter, governments face a difficult trade-off; namely, how much reduction in employment and economic activity should be accepted as a result of providing more liberal opportunities for social interaction.

Social choice is also complicated by the fact that collective responses to new pandemics, such as COVID-19, depend heavily on prevailing political systems and the various goals of rulers. In the case of COVID-19, this (along with uncertainty about the epidemiology of the virus and its impact on public health and economic activity) has led to noticeable differences in the methods used by different governments to control the spread of COVID-19. Infections and the severity of their social restrictions. Moreover, especially in democratic countries, control depends on the political opinion of the public. When the death rate is high, government actions to take measures to reduce it become common, but once the death rate falls, then there are usually strict requirements to loosen social restrictions. This can trigger a new wave of infections, in which the process is repeated again. This process was evident in several European countries, such as Spain and France [34]. It is well known, the degree of economic recovery from COVID-19 depends on treatment aimed at preventing COVID-19, such as the discovery and mass production of an effective vaccine or the search for means to reduce the severity of infections. However, it is unlikely that this disease will be eliminated, and, like the flu, it can change its shape (mutate) over time.

The speed and nature of recovery from the pandemic will be constrained by both supply-side
and demand-side factors. On the supply side, many manufacturers and other businesses depend on international supply chains to support their economic activities. This causes a synchronization problem [35]. It countries that are ready and willing to resume production of goods (but rely on international supply chains for their production) may find that their ability to do so is limited because their international suppliers are unable to meet their needs due to ongoing closures or because they are being reduced, as a consequence of COVID-19. International deliveries may also be limited by interruptions in the provision of transport services, such as air services. For example, China's recovery may be difficult, due to disruptions in its supply chains, as well as lagging in the recovery of demand for its exports. In the recent past, China has shown a high degree of dependence on imported components used in the production of its goods. As such, it was highly susceptible to supply-side interruptions. This, together with its high dependence on exports, has created serious economic problems for the Chinese government in response to COVID-19, not to mention the problems created by trump's "trade war" with China.

Many countries face restrictions on international supply and demand regarding the level of economic activity and its recovery, given the presence of COVID-19. For example, Australian farmers have experienced delays in the supply of spare parts for agricultural machinery and agrochemicals, such as herbicides, due to transport delays or supply shortages. However, the supply chain disruption appears to have been more severe in the early stages of the pandemic than in the later stages. Timely international supply chains had to be replaced by others or by increasing domestic production [36].

As for demand side, aggregate consumer spending is likely to recover slowly due to lower disposable incomes and because consumers do not buy goods that increase their risk of COVID-19 infection, or do not buy them in large quantities. Even when government restrictions on international travel (and even travel within the country) are removed, many people will not be inclined to make this journey, especially with the help of means that increase their chances of Contracting COVID-19, such as types of collective transport, such as planes, trains, buses and ships. Similarly, many people will continue to avoid actions (for some time) related to mass gatherings. Demand is likely to slowly recover only for products produced by those industries that sell discretionary goods and for which their buyers face increased risks of COVID-19 infection. Consequently, economic recovery in some industries will be constrained by both of these factors, i.e. reducing discretionary purchases and avoiding risks when purchasing goods.

Of course, those industries that are slowly recovering from the end of the socio-economic hibernation period designed to combat COVID-19 will also slow the recovery of those industries with which they have a high degree of economic interdependence. Cross-industry analysis (such as input and output analysis) can be used to help measure these inflow effects.

Now there is a dangerous international situation. Many countries may adopt protectionist policies to counteract the decline in economic activity and employment caused by the COVID-19 pandemic. This could delay the global economic recovery. This will put at a disadvantage countries (such as Australia and Germany) that are highly dependent on exports to increase their level of economic activity and employment [37].

4. DISCUSSION

Taking into account both the direct and indirect economic impacts of infectious diseases when analyzing or estimating costs requires the involvement of relevant and affected sectors. It may be difficult to identify, attribute, measure, and compare indirect losses (such as livestock, travel, recreational, or educational impacts), as well as costs incurred due to public communications, transport disruptions, or changes in policies, observation, or biosecurity measures for personnel.

Moreover, while the disease can negatively affect one sector, it can potentially benefit another, as it was evidenced by Giotko et al. [38] regarding the digitalization of different sectors. It is necessary to decide which sectors to include in the assessment and how far to extend them over time and geographically. However, country-level comparisons can be practical and useful for making decisions on budgets, regulations, and agency mandates.

Stakeholders will differ depending on the specific disease, its scale, and range of impacts. The economic consequences of unpredictable infectious diseases can be detrimental not only to
public health systems, but also to the food and agriculture industry, trade and travel, various types of markets and retail chains, mining, oil and gas companies and suppliers of natural resources, the environment and ecosystem services, among others. These sectors have traditionally not been directly involved in disease impact assessment or readiness planning (including prevention efforts), but they are increasingly aware of the threat of natural disasters to health when consumers are too scared or unable to access their services due to the supply chain or other business continuity, or their employees are directly compromised. Including relevant non-health stakeholders in risk and impact assessments can provide more informative health impact assessments and increased awareness of readiness opportunities, and can provide access to new collaborations and potential risk reduction and resources.

For example, the agricultural industry can promote strict biosecurity practices in its supply chains, the pharmaceutical industry can improve regulatory mechanisms or guidelines that prevent the development of antibiotic resistance, utilities can promote water supply methods that minimize health threats, and the energy and mining sectors can provide employees with a safe and reliable source of protein to reduce risky hunting practices for wild animals, which may be related to the development of natural resources.

The world economic forum has developed recommendations on public-private collaboration models to better manage any potential outbreaks in the future and reduce the risk of their occurrence. Industry-specific risk reduction guidelines, whether adopted voluntarily or embedded in donor or private funding mechanisms, can also help in long-term disease prevention or management; for example, audit and planning tools aimed at reducing the risk of infectious diseases have been developed for the extractive industries.

The value of risk reduction is consistent with the recent inclusion of "disease X" in the WHO research and development plan, which recognizes that the next epidemic may be caused by a pathogen that is currently unknown or unexpected. The broad impact - both proven and potential - of known and unknown diseases requires confidence that disease risks, responses, and recognition of impacts are not confined to the health sector.

According to an analysis by the World Bank, the economic damage caused by six major high-fatality zoonotic outbreaks between 1997 and 2009 was at least $80 billion. If these outbreaks were prevented, the averted losses would amount to an average of up to $6.7 billion per year. The widespread - and often significant - economic consequences of epidemics are increasingly recognized far beyond the health sector. However, few studies use the concept of "National health" or a multisectoral lens to consider the costs and benefits of prevention versus response efforts during planning to ensure resource optimization.

5. CONCLUSIONS

Recent activities related to the priority of zoonoses under the Global health security agenda have provided an opportunity for countries to consider the direction and scope of their investments. Where possible, investments should be directed towards strengthening the overall health systems of humans, animals and the environment to ensure preparedness for multiple hazards and broad social benefits. The availability of quantitative data on exposure was noted as limited for serious diseases of farm animals; the results of our review are consistent with this, and also suggest that the health consequences of emergencies caused by infectious diseases are significant, but reporting is random and probably incomplete. Public and private stakeholders in coping with epidemics and pandemics at the local, national and international levels should work together more systematically to provide informed systems and risk and impact analysis, as well as promote cost-sharing strategies for prevention and preparedness where possible, and evaluate optimal intervention strategies when necessary. Developments related to infectious diseases in today's globalized world require increased responsibility for preserving people's health and economic security. The occurrence and consequences of epidemics and pandemics depend on the nature and stages of economic development. The economic and social structure of modern society contributes to the transmission of diseases that depend on human contact or presence, especially those that are caused by airborne microbes or persist on commonly used surfaces. The latter characteristics contributed to the rapid spread of COVID-19 and left no time to respond to it. Developing appropriate policies to control it was also difficult in the early stages due to a lack of...
knowledge about epidemiology and many other characteristics.

CONSENT
It is not applicable.

ETHICAL APPROVAL
It is not applicable.

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