

Review Article

Emerging One Health Preparedness to Combat National Burden of Diseases in Pakistan: A Comprehensive Insight

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Abstract

In order to integrate and enhance the health of people, animals, and the environment, a multidisciplinary “One Health” concept has been coined. However, developing countries have frequently lagged in embracing this innovative vision. Pakistan’s ecology, human health, and animal health have all been severely jeopardized due to a lack of resources. Human health is significantly impacted by the spread and comeback of zoonotic illnesses, especially for people who live in rural regions and frequently interact with domestic or wild animals. More than 75% of zoonotic diseases were transmitted contiguously from animals to humans or indirectly through interactions among agents or vectors (including both humans and other animals). This review article gives critical insights into the most common zoonotic diseases found in Pakistan in addition to underlining the importance of the “One Health” philosophy in the management of these illnesses. Interdisciplinary research efforts are required given the current circumstances in order to politicize sustainable solutions for decreasing the disease burden in human and animal populations simultaneously.

Introduction

One Health is a transectorial multidisciplinary idea that conceptualizes integrating and improving the health of people, animals, and the environment. However, underdeveloped nations have often lagged behind in adopting this novel viewpoint. Owing to insufficient resources, Pakistan’s ecology, human health, as well as animal health have all been seriously compromised. Human health is profoundly impacted by the establishment and re-emergence of zoonotic illnesses, especially for people who reside in underdeveloped areas and are frequently in contact with farm animals or wildlife [1].

The diseases known as zoonosis are brought on by

microorganisms that spread spontaneously from animals to people. Since zoonosis account for almost 60% of the total infectious disease burden, the continued presence of zoonosis poses serious dangers to public health transmissible diseases [2,3]. Approximately 75% of zoonotic infections are spread either directly from animals to people or indirectly through interactions between animal and human vectors and agents. Growing human and cattle populations, urbanization, globalization, and environmental interactions all contribute to the origin and spread of zoonotic diseases [4,5]. Pakistan’s terrain, climate, and variety of domestic and wild animal species are all quite diversified. Similar to how climatic change may affect disease monitoring systems and public health, so can ecological variations, law and order, wealth disparity,



resource lessness, national and international rivalries, and absence of political motivation [6,7].

The one health strategy is important for preventing and controlling zoonosis. The World Health Organization (WHO) and Graham, et al. have remarked that 75% of newly developing infectious illnesses in people are classified as zoonotic, meaning they may spread naturally from vertebrate animals to people [8]. Over the last three decades, new and reemerging zoonosis has developed in part as a result of our intimate relationship with companion animals as well as our growing dependency on animals and their products. In light of infectious illnesses, zoonosis should be regarded as the most significant risk factor for human health and well-being [9]. Numerous non-governmental organizations (NGOs), and government organizations involving ministries for climate change, town development, and food safety are working in collaboration to develop and implement innovative and practical strategies to control and prevent zoonotic diseases in Pakistan [10]. Although the details of controlling various types of diseases vary, a One Health approach that takes the entire supply chain into account is the most effective way to prevent them all. From a One Health perspective, such preventative and holistic approaches offer a tremendous opportunity to improve food safety by potentially reducing the financial and health burden of disease on emerging nations [11].

In the rich tapestry of zoonotic landscapes within Pakistan, several noteworthy infectious agents traverse the interstitial realms between animals and humans, encapsulating a spectrum of maladies that demand heightened scrutiny. Foremost among these is Leishmaniasis, an insidious parasitic affliction transmitted through the bites of infected sandflies. The endemicity of Leishmaniasis in Pakistan is intertwined with ecological factors and human behaviors, necessitating meticulous examination to unravel its complex epidemiology. Brucellosis, an infectious jewel in the zoonotic diadem, asserts its presence with particular prominence. This bacterial malady, propagated by the genus *Brucella*, manifests as a symphony of malaise, fever, and joint afflictions. The intricate dance of transmission, often facilitated by contact with infected livestock, mandates a strategic choreography of surveillance and prevention. Avian Influenza, with its feathery guise concealing viral intricacies, resonates as a poignant concern. The interplay between migratory birds, domestic poultry, and human susceptibility paints a chiaroscuro of potential pandemics, emphasizing the urgency of monitoring and intervention strategies to avert viral crescendos. Cryptosporidiosis, an enteric ballet choreographed by the eponymous protozoan, intricately weaves its narrative through waterborne transmission routes. In the mosaic of zoonotic concerns, this parasitic interlude underscores the paramountcy of water hygiene practices and livestock management. In the realm of vector-borne elegance, Crimean-Congo Hemorrhagic Fever emerges as a formidable waltz

between ticks and humans. The intricate choreography of this viral zoonosis demands a nuanced understanding of tick ecology, livestock engagement, and human vulnerability to orchestrate preventive crescendos.

As the narrative unfolds, these zoonotic vignettes underscore the exigency for heightened surveillance, interdisciplinary collaboration, and targeted interventions. A lyrical symphony of research, policy, and public awareness is requisite to navigate the intricate cadence of zoonoses in Pakistan, harmonizing the well-being of both fauna and humanity.

Common zoonotic diseases in Pakistan

WHO defines zoonosis as any disease or infection that is naturally transmissible from vertebrate animals to humans [12]. The major common zoonotic diseases in Pakistan include Bacterial (salmonellosis, brucellosis, anthrax, dysentery, bovine TB, Weil's disease, Q fever), viral (Rabies, Hepatitis-E, Crimean-Congo Hemorrhagic fever, Chikungunya, Rift Valley Fever), Vector Borne (leishmaniasis, Chagas disease), Helminthic (lumbricoides, enterobius species, ancylostoma duodenale, trichuris trichiura, taenia spp., echinococcus), Protozoan (giardia lamblia, cryptosporidium species, isospora) [1,13-15]. Bovine TB (bTB) is an alarming situation for public health right now, particularly in developing states like Pakistan. The prevalence of bovine TB in the butchery workforce, cattle farmers, and veterinary health professionals is quite high [16]. Bovine TB is transmitted from infected animals to humans via coughing, sneezing, or through raw milk consumption [17].

In bacterial zoonotic diseases of Pakistan, Brucellosis and Q fever (causing factor; *Coxiella burnetii*) are serious health hazards that have been neglected. In Pakistan Brucellosis is endemic yet the true incidence of the disease remains unknown throughout the developing world. It is a multi-organ disease, with a focal complication rate of 31.9%, the most common being osteoarthritis and spondylitis, followed by epididymo-orchitis, and hepatitis [18]. *Coxiella burnetii* is a resistant bug that survives adverse conditions such as dryness, heat, and disinfection quite frequently. *C. burnetii* infection mostly does not produce major symptoms and is thus underdiagnosed. Its incidence is often identified by a large number of abortions in a particular population [19] [14]. However, it can present as an acute disease- usually as a self-recovering flu, pneumonitis, and as an acute liver disease, or as a chronic pathology- mostly in the form of endocarditis [20].

Leptospirosis, the most common zoonotic disease in the world, spreads readily by animal urine. It can cause a self-limited flu-like disease or a chronic fatal disorder known as Weil's disease, which may culminate into multiorgan failure [21]. Since it is in its emerging phases, therefore, it is very underrated and does not receive its due emphasis in Pakistan [15].



In viral zoonotic diseases of Pakistan, rabies is the oldest recorded and neglected endemic disease of Pakistan. Dogs are considered to be responsible for about 99% of human deaths associated with rabies [22,23]. The saliva of animals transmits the virus resulting in uniformly fatal viral encephalitis. Due to extensive vaccination, the disease has become a rare occurrence in developed countries like the US, however, it still haunts developing countries, causing up to 70,000 deaths per year [24].

Crimean-Congo Hemorrhagic Fever (CCHF), a viral illness carried by ticks, is characterized by its four distinct phases of incubation followed by pre-hemorrhagic, hemorrhagic, and consequently convalescence. The hemorrhagic phases show mortality up to 50% while a convalescent phase with fever and chills may last as long as a year (Shayan, et al. 2015). Studies have shown a 2.7% seroprevalence in Pakistan; significantly higher in the rural population, summer season, and during the festival of Eid-ul-Azha [25]. Its prevalence also contributed to poor sanitation and unsafe transportation of slaughter wastes within cities [1].

Hepatitis E has been identified as a zoonotic disease, transferable from cattle to humans. It exists as an epidemic in several Northern and Western areas of Pakistan. Its outbreaks are almost always related to sewage contaminating the local drinking water reserves [26]. In vector-borne diseases, Leishmaniasis is one of the major endemics in Pakistan. It presents in various ways from self-healing form to fatal systemic disease [27] [28]. Occurring in two major forms: visceral and mucocutaneous leishmaniasis, the disease has been strongly linked with poverty [29]. The dengue epidemic surges every year or alternate year, causing a large number of hospitalizations and mortalities [30]. The manifestation of dengue can range from being asymptomatic or a mild fever, to dengue hemorrhagic fever, showing extensive plasma leak and multi-system failure [31].

The prevalent Helminth parasites transmitted from animals to humans in various areas of Pakistan are most commonly Strongyloids, Trichuris, enterobius vermicular, and ancylostoma duodenale. Around half of the animal samples from analytical reports in certain areas of Pakistan were positive for having nematodes, cestodes, and trematodes [32,33].

In Animal-borne Protozoan diseases, Giardia intestinalis is known to be the most common protozoan causing enteric infections, particularly affecting children. It is quite prevalent in Pakistan. Statistical reports show that it is associated with residency and socioeconomic status [34]. Another protozoan parasite transmitted from animals, especially from sheep to humans is Cryptosporidium spp. It is an opportunistic zoonotic parasite. It infects humans and wild, and domestic animals. The incidence of Cryptosporidium-caused disease was recorded to be relatively high in three

seasons; spring, summer, and autumn but the winter season seems unfavorable for the pathogen [35]. Using academic, peer-reviewed literature that has been published since the concept's widespread acceptance, the major focus has been on zoonosis with the overarching goal of determining the state of the one health approach and its applicability to zoonosis.

Overcoming zoonotic diseases in Pakistan through one health

The effects of global environmental changes: The detrimental effects of environmental changes are well-known globally and locally. Global warming is constantly causing sea levels to rise. The rate of increase in global mean sea level climbed to 3.2 ± 0.4 mm/year from 1993 to 2009, from 1.7 ± 0.2 mm/year in the years 1900 to 2009 [36]. Coastal land, in excess of 100,000 acres now lies under water due to sea intrusion (Memon 2004), meanwhile the mangrove distribution has crippled down from 250,000 hectares [37] to about 98,000 hectares [38] in the last few decades. This poses a significant social and economic threat to the population dependent on coastal plant life for food, timber, firewood, and fodder.

Pakistan has seen a sharp rise in the number and scale of floods in the last decade. As per the Planning Commission of Pakistan, the country's agricultural sector, including livestock and fish farming, incurred a net loss of 3.7 billion dollars in the devastating floods of June and August 2022, but the farmers have largely failed to receive any compensation for their losses from the government [39]. The resultant nutritional deficiencies render the health of flooded communities at risk of several nutritional and infectious disorders. A survey by Haq, et al. 2021 [40] demonstrated a deficiency of almost all essential micronutrients in areas afflicted with floods. Floods in 2022 saw a rampant increase in skin diseases, acute respiratory illnesses, and diarrhea outbreaks (Ilyas 2022) [41]. Although floods result in direct mortality and diseases of livestock, the forced displacement of the population sets off a poverty-driven positive feedback loop with a lack of access to optimal nutrition and health care, which harbors a major risk for the spread of zoonoses [42]. Moreover, the rapid turnover of vector-borne illnesses, for example, malaria, dengue, and leishmaniasis, further complicates the issues of suffering communities [43]. Contaminated water bodies provide a medium for the spread of leptospirosis [44]. Leishmaniasis, spread by the sand fly, has been well documented to spread in relief camps, owing to malnutrition and overcrowding [45].

Although global warming is expected to increase the global crop yield -the "fertilizer effect", its uneven distribution will adversely affect African and South Asian agriculture, causing spells of heavy floods followed by periods of long droughts [46]. The increase in maximum temperature has been shown to produce a quantifiable decrease in the yield of wheat, rice, and sugar cane crops in Pakistan [47]. Gupta, et al. 2007 [48] showed that in India, global warming caused wheat production to drop by 5.2% from 1981 to 2009. Farmers need



to strategize and adapt to climate variability in order to sustain food production, though this is dependent on the provision of well-guided information and thoughtful government policies [47].

The importance of food and water hygiene

Various pathogens of viral and bacterial origin can infect human populations. The main source of their transmission is either aerosols or contamination of water sources [49]. In developing nations like Pakistan, water-related issues, ranging from droughts to severe floods and excessive rainfalls, are on the rise as a result of climate change. Due to these environmental changes, water quality is depreciating and waterborne pathologies like hepatitis, typhoid, dysentery, cholera, and mosquito-borne illnesses are rising. Industrialization, urbanization, unsanitary conditions, and improper water management are major causes. Due to a shortage of medical care availability, particularly in underdeveloped nations, the disease burden is relatively much higher [50].

Both industrialized and underdeveloped nations experience serious health issues related to foodborne illnesses. Due to widespread improper food handling and sanitation practices, almost non-existent food safety laws, weak regulatory systems, a lack of financial resources to purchase safer equipment, illiteracy, and lack of awareness among food handlers, the issue is particularly more pronounced in low-income nations [51]. The unclean hands of food service employees are a major transmission source for the spread of foodborne illness, primarily due to neglect of personal hygiene, and are responsible for roughly 97% of foodborne illnesses in households and food service companies [52].

Even though there has been rapid development in the field of medicine, arthropod-borne diseases continue to haunt public healthcare workers. Arthropods, peculiarly insects and arachnids, make up the majority of pathogenic vectors. Insects primarily transmit illness by stings, bites, tissue invasion, and indirect pathogen transmission. The common house fly (*Musca domestica*) and the larger house fly (*Muscina stabiles*), both of which have a nearly global distribution, are perhaps the most significant vectors for the transmission of zoonoses. House flies can transmit viruses, fecal bacteria, protozoa, and helminths, which can spread enteric diseases including dysentery and typhoid. A variety of pathogens are carried by cockroaches, particularly *Blattella germanica* and *Periplaneta Americana*, which often cause gastroenteritis. On their bodies and legs, they carry microorganisms which are then deposited on the food they consume. It's crucial to maintain proper cleanliness, manage vector populations, and ensure vaccination to halt the spread of these diseases [52,53].

Street food vending is a common site throughout the world and is even more common in developing nations, however, it comes with its own risks for the spread of zoonotic infections

[54]. A study conducted in Rawalpindi showed that 80% of food stalls, irrespective of their type, were improperly covered, with rather unhindered access for flies and other insects, placing the food at extreme risk for contamination. A large majority (75%) agreed to use tap water for food preparation. Overall, the attitude shown by street vendors lacked professionalism and food hygiene ethics [55].

To safeguard the customer, there needs to be a specific set of municipal and federal laws governing street food, and an emphasis on professional training and education of street vendors [56]. The most economical method of preventing infectious diseases is the promotion of hygiene and food safety; however, neither the health nor the water and sanitation sectors prioritize and invest significantly in this area [57]. Millions of people's health and life quality will be enhanced if everyone has easy access to sufficient clean water, and good sanitation, and is educated in practices of personal, household, and communal cleanliness. In addition to reducing the significant burden of disease brought on by conditions like diarrhea, respiratory infections, and malnutrition, adequate washing is crucial for the management and eradication of numerous neglected tropical diseases, which affect more than one billion people [58].

Food and animal safety

The One Health concept advocates a transdisciplinary approach toward food and animal health since these are closely interlinked with human health. Pakistan ranks high on the list of largest milk producers and consumers. Yet the quality of milk available to the public is highly questionable. A longitudinal study on Islamabad's milk products showed that 12.9% of UHT milk, 41.0% of pasteurized milk, 91.9% of raw milk, and 50.0% of the powdered milk samples, had more aflatoxin M1 than 500 ng/L limit by Codex [59]. This requires a comprehensive approach involving the education of farmers as well as strict monitoring and legislation from the government [60]. Boiling, pasteurization, and ultra-high temperature (UHT) techniques are used to preserve milk; while UHT appears to be the most effective method for disinfection [61], it exerts the most significant impact on the nutritional profile of milk [62].

Human and animal brucellosis presents a major disease load in the agricultural community in Pakistan [19]. Since humans present the end hosts, the human disease burden directly reflects the disease burden in animals. A one-health approach with emphasis on animal vaccination, screening, and farmer education is desperately needed [19].

Echinococcus, labeled as the neglected tropical disease by WHO, had a reported prevalence of 2.44% - 35% in cattle, 7.19% - 24.40% in buffaloes, 3.24% - 8.85% in sheep, 2.44% - 6.61% in goats, and 17.29% in camels, between the years 1989 to 2015, as per reports from various areas of Pakistan [63]. This pathogen, on average, causes financial losses of



2.76 dollars per diseased goat or sheep and 1.65 dollars per diseased cattle or camel in Pakistan [64]. This is in addition to human morbidity. Prevention of this disease lays emphasis on periodic deworming of dogs, better hygienics in the slaughtering process including proper elimination of waste products, and efforts for enlightenment of the general public regarding this pathogen. Vaccination has also shown some promising results (WHO) [65].

A study showed a 26.45% prevalence of Avian flu in layers farms in Karachi, declaring the disease to be endemic [66]. Various outbreaks in the past have incurred huge financial damages to the poultry sector. The government has been working on vaccination plans to curtail such damage in the future [67] Food-borne helminths and protozoa form a major portion of the zoonotic disease burden in humans. A study showed a 59.8% infection rate with one or more parasites among the food handlers [68]. The highest infection rate was by *Ancylostoma*, followed by *T. Saginata* and *A. Lumbricoides*. UIHaq, et al. [69] showed an alarming 82% infection rate with intestinal parasites in school-going children. Urgent measures are required to ensure improvements in food handling as well as deworming in the pediatric population.

The control of vector-borne illnesses

Infectious diseases are continuously evolving and re-emerging, and zoonoses form a major chunk of these pathologies. Changing landscapes, global warming, and evolving agricultural methodologies have a role to play [70]. WHO has predicted an increase in annual deaths by 250,000 per year, between the years 2030 to 2050, and vector-borne diseases like malaria have a significant share. The rise in temperature and humidity is associated with an increased burden of insect-vector-borne diseases such as malaria, leishmaniasis, plague, and Japanese encephalitis [1]. Further, the pattern of emergence of zoonoses has been greatly influenced by the development of cities, animal migration patterns, genetic evolution in vectors, domestication of animals, and others. A large majority of people are in contact with animals, and thus provide an easy route for transmission of zoonotic diseases [71].

Throughout the world, dogs are equally popular as a pet in both cities and rural areas. But this comes at the risk of transmission of diseases including many vector-borne illnesses such as Rabies, Leishmaniasis, and Echinococcosis [72]. Pakistan ranks in the top 5 states with the most rabies victims. There is a dire need for easy availability of rabies prophylaxis in government healthcare facilities, large-scale dog vaccination, enforced responsible animal ownership, practical application of the One Health system, and laboratories with sufficient surveillance resources to prevent this disease [22]. On the other hand, cutaneous and visceral leishmaniasis, mainly affecting poor communities, is a neglected vector-borne disease and is endemic in Pakistan [27]. The lack of expert medical professionals in rural areas,

as well as the scarcity of medicine further complicates the issue (Shairaz & Muneeb 2005). There is an emergent need for rigorous vector control through insecticides, availability of personal protective equipment, a strong surveillance system, and education of affected communities. (WHO) [73]. Lately, COVID-19, which wreaked havoc globally causing utmost destruction to human life and the economy, has been also labeled as a zoonotic disease, with bats being a probable vector of origin (Rahman, et al. 2022).

Four dengue serotypes are present in Pakistan and circulate throughout the whole year with peak outbreaks between September and November. Dengue fever has been responsible for around 12 countrywide large outbreaks in Pakistan, resulting in 286,262 morbidities and 1,108 deaths [74] Prevention strategy highly relies on insecticide sprays but resistance has been noted among mosquito species [75] Some of the strategies that are useful for eradication of *Aedes* mosquito include unified vector management plans, halting the breeding capacity and growth of mosquitoes through water regulation and insecticides, proper collection and disposal of domestic and commercial waste, as well as spreading awareness among the general people [76]. To control the rise of vector-borne zoonotic, there is a need for a system that relies on strong surveillance and implements practices to inhibit the growth of vectors and the transmission of diseases [77].

Population control, socioeconomic stress and its impact on healthcare

Pakistan's population at the current time is estimated to be above 230 million, with rampant growth of over 25 million in the last five years [78]. Coupled with the crippling economy, the healthcare sector is bound to lack necessary financial and decision-making support. Macroeconomics has always had a huge impact on the healthcare of the masses [79]. Overpopulation has a major role in fueling the spread of epidemics and pandemics [80]. Population growth has detrimental effects on plant and animal biodiversity of the area, which then through various mechanisms, translates to increased transmission and pathogenicity of different zoonoses [81]. Population increase also means a need for increased food production, thus leading to the emergency of large-scale concentrated animal farms, which house a perfect environment for harboring various pathogens [82]. Another issue that comes along with increasing population density is the housing crisis, forcing millions of people into urban slums. Overcrowding and unavailability of sanitation and health facilities make this population particularly susceptible to zoonotic diseases [83].

Zoonotics are far more prevalent in poor or middle-income countries. This reflects the absence of proper healthcare programs for the people, as well as poor veterinary care for animals [84]. Vector-borne diseases like malaria and



leishmaniasis, as well as other grave illnesses like HIV and tuberculosis disproportionately attack the underprivileged population, and with the compounding malnutrition disorders, the prognosis is far poorer than in developed countries [85]. The zoonotic disease needs to seek the attention of the international community in areas of management, planning, infrastructure, education, and financial resources. Furthermore, there is a need for intersectoral cooperation and innovative strategies involving all stakeholders to curb the burden of zoonoses [86].

Surveillance of disease outbreak

Surveillance is a major tool to gauge, quantify, and qualitatively describe the disease burden in a community. These are the aims of surveillance: (1) to provide a depiction of the current load and disease epidemiology (2) to keep track of new incidences and previous prevalence and (3) to detect fresh outbreaks [87]. Many zoonotic diseases widely affect life in Pakistan. The factors that cause the spread of such diseases and help them spread need to be studied to understand the risk factors linked with these diseases to prevent them. This requires the study of epidemiology to help identify the number of people that have been with these diseases so far and to study the disease trends [88].

Despite these diseases affecting such an alarming number of people in Pakistan, the surveillance process still faces many challenges. The main challenge is in the form of logistics and financial resources. The topography of Pakistan makes it difficult for all areas to be easily accessible, and the means of communication still lag behind the modern-day requirements [89]. Further, Pakistan roughly allots a mere 1% of its net GDP to the healthcare division, compared to a 5% recommendation by the World Health Organization [90]. The investigation and study that is currently being done is only event-based. If some data is collected from different resources, it is not shared among the concerned public health departments for necessary actions. While Pakistan has developed its own IDS to monitor and collect information on prevalent infectious illnesses, the whole process is rather below-par and undependable [89]. There is a shortage of technical resources and expert supervision at the primary and secondary levels to diagnose and record zoonotic diseases, thus a significant number of cases either remain undiagnosed or are misdiagnosed. However, Disease control strategic plans are being made in collaboration with the CDC to build a capacity to study the extent of these diseases to prevent and control these diseases in Pakistan. To control these diseases, a collaborative health approach is needed from both the human and animal health care systems [91].

The role of health education

The World Health Organization (WHO) defined Health Education as consisting of “consciously constructed opportunities for learning involving some form of

communication designed to improve health literacy, including improving knowledge and developing life skills which are conducive to individual and community health [92]. The objective of health education is to create an immediate impact on the knowledge, behavior, and attitude of the general public regarding health-related topics, and to foster a healthy lifestyle in the community. The association between health illiteracy and infectious diseases is well-established in the literature. Education of the general public regarding the disease pathogenicity and transmission is the most important tool in its prevention. However, the knowledge has to be simplified and streamlined to cater to local literacy and educational levels [93].

Perhaps one of the most significant parts of “One Health Paradigm” is the large-scale promotion of health education. Since Her creation, Pakistan has made progress in various areas, but its medical advancements have been lacking for several reasons. The separation between clinical and preventive medicine, along with a shortage of medical personnel, lack of public cooperation, and the presence of deadly diseases, have been obstacles to progress. Furthermore, political mismanagement, unavailability, resource lessness, a dismal Health Information Management System, corruption, and inconsistency in policies and planning have contributed to a lamentable development in the health sector over the last five decades [94]. Like the health sector overall, public health education appears rather neglected. Despite seeing significant growth in this field lately, public health education standards fall short of international guidelines and are insufficient to meet the challenges faced by the country [95]. A major resistance to the provision of health education to the general public is the reluctance of trained health professionals such as doctors and nurses to work in rural areas of Pakistan for several reasons [96].

Conclusion

Pakistan still houses a large burden of zoonotic diseases owing to several factors such as poverty, lack of education, and poor hygiene. As human diseases are closely interlinked with animal diseases as well the environmental factors, there is an urgent need for a “One Health” approach, to form a multisectoral integrated policy with the aid of human and veterinary healthcare departments, along with authorities concerned with environmental changes, city development and public welfare.

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