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ZOONOTIC SPILLOVER AND THEIR RELATIVITY TO PANDEMICS

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ABSTRACT

The study aims to emphasize the relativity of pandemics and their zoonotic spillover. During recent decades the chance of pandemics occurring has increased many folds. So, the study thoroughly reviewed seven zoonotic spillovers from bats in history that led us to the common feature that close contact of bats with other species including humans is the major reason for pandemics. Due to anthropogenesis bats started moving into buildings for survival, reproduction, and swarming became the susceptible source of disease transmission. The study aims to suggest measures that could help to prevent bat-borne viral outbreaks in the future.

1. INTRODUCTION

The ongoing wave of Coronavirus disease-19 (COVID-19) pandemic around the globe caused by SARS-CoV-2 became a global public health concern (Jin *et al.*, 2020, Rothan & Byrareddy, 2020). It is obvious that bats are the convenient reservoir of the CoVs and probably the etiological agent of COVID-19 (Sabir *et al.*, 2016).

In the past century, Asia, Africa, and Arabian states were the major hotspot regions related to bat-born viral pandemics in human society (Calisher *et al.*, 2006, Wolfe *et al.*, 2005, Morse, 2004). We studied seven zoonotic spillovers that are Marburg virus (Towner *et al.*, 2009, Nyakarahuka *et al.*, 2016) , Ebola virus (Smith, 1978) Nipah virus (Paton *et al.*, 1999, Chua *et al.*, 2000), Hendra virus (Blum *et al.*, 2009), Severe Acute Respiratory Syndrome coronavirus in (Christian *et al.*, 2004) Middle East respiratory syndrome (Skariyachan *et al.*, 2019) and COVID-19 (Jin *et al.*, 2020).

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When we studied briefly these spillovers that resulted in the growth of the human population intensified the anthropogenic interference to wildlife (Plowright *et al.*, 2011). Wild animals are the potential hosts of viral diseases as in the case of Hendra, Nipah, and SARS-CoVs (Chua *et al.*, 2000, Philbey *et al.*, 1998, Murray *et al.*, 1995a). Similarly, the reason behind the EBOV and SARS-CoV outbreaks is the cultural traditions of eating wild animal meat or 'bush meat' in Africa and Asia (Dowell *et al.*, 1999). Businesses in live markets such as the desire for eating wild bats conceded the susceptible animals to come into contact with bats and let the transmission of SARS-CoV into the human's population (Webster, 2004, Guan *et al.*, 2003a, Lam *et al.*, 2003). On the contrary, in the case of MERS-CoV outbreak civets dromedary camels were identified as major intermediate hosts that were got infected elsewhere from the reservoir host (Zaki *et al.*, 2012).

Moreover, the anthropogenic activities including deforestation and urban development with the increasing human population selecting synanthropic bat species, and so far the bats are benefiting from living close to humans, thereby increasing their numbers and the risk of disease transmission to humans (McFarlane *et al.*, 2012). The origin of the COVID-19 pandemic outbreak is still debatable but the very first cases of concentrated pneumonia were informed in Wuhan city of China and were linked with the wet animal market. Because of high human to human transmission, the COVID-19 rapidly spread to other countries of the world and global health emergency was announced by WHO (Jin *et al.*, 2020, Rothan and Byrareddy, 2020). The aim of our study is to curb pandemics in future. So that, we thoroughly reviewed seven zoonotic spillovers from bats in history that led us to common feature that is close contact of bats with other species including human is the major reason of pandemics. Due to anthropization bats started moving into building for survival, reproduction and swarming that became the susceptible source of disease transmission. Our suggestions could help to prevent bat-borne viral outbreaks in future if seriously implemented.

Zoonotic Spillover from bats

Spread of viruses via bats causing EIDS (Emerging infectious disease) is a major issue. A list of bats born dreadful pandemics/epidemics outbreak in human populations all over the world is given in Table 1 and Figure 1. The mode of transmissions of viral pandemics/epidemics to the human population from different reservoirs is represented in Figure 2. This figure also explained that bat close contact in outbreak areas becomes the source of disease transmission. Our suggestions could help to prevent bat-borne viral outbreaks in future if seriously implemented listed below.

Why bat research always our week area?

Americans were on the belief that bats are violent enough to attack human and pets even organization which worked for bat conservation used to avoid bats because of fear (Tuttle, 1979). Therefore, deep research is much needed in broad spectrum which should be able to cover all aspects of bats.

Minimize anthropogenic activities

Area of forests has been lessened and environmental diversity is nearer to human population due to anthropization. Unlike their natural habitat, these landscapes provided a large number of bats to make their habitat in this anthropized environment. Bats found there niches in human populated areas which are their alternative environment for their survival (Walsh *et al.*, 2017a, Afelt *et al.*, 2018).In the name of urbanization, large scale deforestation has been done that threatens and disturbing the natural habitats, bats started changing their habitat and moved to urban areas that made close contact with humans. If we do reforestation bats can be revived to their original habitat and it will also help the ecosystem, whereas the problem of the increasing population can be controlled by the social campaign, social awareness, education, and proper planning.

Detecting synanthropic bat species

Most of the species are living in man-made buildings in which bats are using different spaces of these buildings which are good element for hibernation and reproduction (Lesinski, 2006). Searching for bats in the buildings and its premises is hard task even for the chiropterologists therefore infrared cameras, endoscopes and ultrasonic detectors can be used to find bats but more inovative technological equipment can be used with the help of chiroptrologists to capture bats.

Chiropterological inventory survey

Roofs, wall cracks, attics can be examined and inspected with use of modern equipment's. It is necessary step that should be practiced during any inventory of bats in buildings and its premises (Janus & Lesinski, 2018). A survey must take place with modern techniques and equipment's with high probability detection rate in new buildings as well as existing buildings and its premises including all spaces, roofs, wall cracks and all possible places.

Create rehabilitees for bats

Killing and capturing of bats has become extensive and not limited in buildings. Major colonies of bats (*Myotis grisescens*) were burnt in caves (Tuttle, 1979) when health officials conjectured i that these species of Bats were outbreak cause rabies in foxes (Fredrickson & Thomas, 1965). This information makes bats very unsafe. Killing and capturing of bats has become extensive and not limited in buildings. Major colonies of bats (*Myotis grisescens*) were burnt in caves (Tuttle, 1979) when health officials conjectured that these species of Bats were outbreak cause rabies in foxes (Fredrickson & Thomas, 1965). Historically, there are always reasons and objects of fear and conflict that came across many societies possibly due to their dark and evasive behavior (Kingston, 2016). Capturing and killing bats or keep them away from buildings is not the solution. We need to make rehabilitation areas for bats in forests, mountains, areas far away from human population where these captured bats can revive, live, hibernate and swarm. By reviving bats and saving its population is necessary as bats play important role in our ecosystem.

Management Implications

Our study can support wildlife management based on bats conservation and its rehabilitation.

2. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interests regarding the publication of this article.

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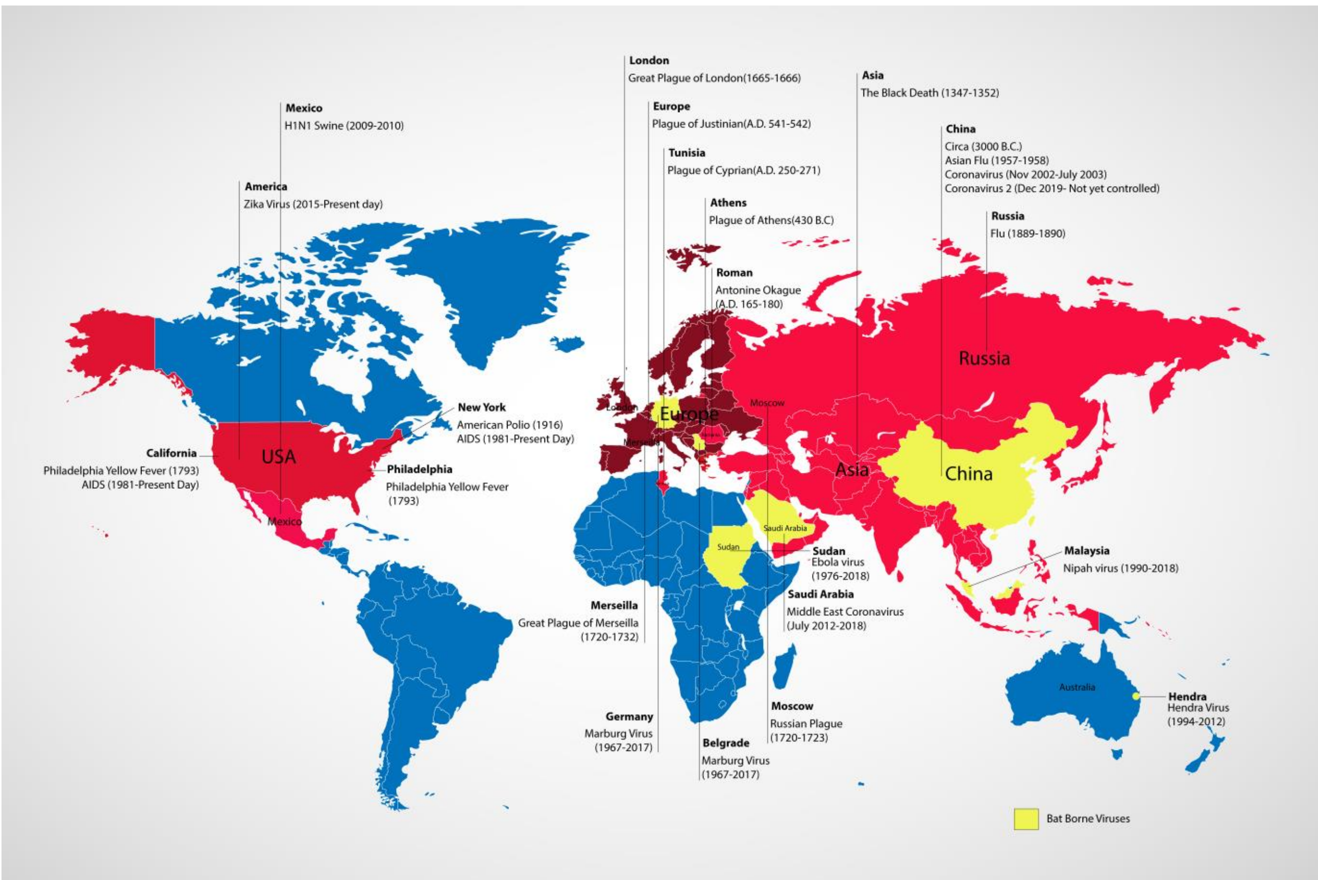

Figure 1: Visual map for the zoonotic spillover

Note: Yellow are representing the bat borne virus in maps

Table 1. A list of bat born dreadful pandemics / epidemics outbreak in human populations all over the world

Virus Name	Origin/ Geographical location	Epidemic potential/ Time period	Target Species /Zoonosis	Symptoms	Incubation Period (Days)	Targeted human's receptor	Causes	Mode of Transmission	Death rate	References
MVD	Marburg and Frankfurt, Germany and Belgrade, Yugoslavia (present-day Serbia)	1967-2017	Bat, Primates, Human	hemorrhagic fever headache chills muscle ache	2-21	TIM-1	Visitor, Experimental study on infected monkeys	Infected Research Areas, Eco-tourism	81%	(Nyakarahuka *et al.*, 2019, Lam *et al.*, 2003, LUBY and SANDERS, 1969, Amman *et al.*, 2012, Sissoko *et al.*, 2017, Timen *et al.*, 2009, Adjemian *et al.*, 2011, Bausch *et al.*, 2003, Beer *et al.*, 1999, WHO, 2018)
EBOV	Sudan	1976-2018	Bat Primates Pigs Human	high fever malaise fatigue and body aches	2-21	TIM-1	Lovers of game meat, Dealing with wild animals	Hunters, Poor medical management	41.7%	(Arunkumar *et al.*, 2019) (Leroy *et al.*, 2009) (McMullan *et al.*, 2019) (Malvy *et al.*, 2019) (Leligdowicz *et al.*, 2016) (WHO, 2020b)
NiV	Malaysia/ Singapore	1990-2018	Bat Pig Human	neurological and respiratory	6-14	EFNB2	Agricultural intensification, Globalized economy	Workers on pig farms, Sale of infected Pigs to another region Persistence of pathogen increased the transmission in pigs and to humans.	39%	(Arunkumar *et al.*, 2019) (Negrete *et al.*, 2005) (Bonaparte *et al.*, 2005) (Arunkumar *et al.*, 2019, Paton *et al.*, 1999, Chua *et al.*, 2000)
HeV	Hendra, Queensland, Australi	1994-2012	Bat Horses Human	influenza-like illness multiorgan failure and	21	EFNB2	Climate change, Habitat loss,	Bats movement in agricultural land Urbanization	57%	(Murray *et al.*, 1995b) (Symons, 2011) (Brearley *et al.*, 2013) (Jones *et al.*, 2013) (Giles *et al.*, 2018)

				progressive encephalitis			Habitat fragmentation			(Walsh *et al.*, 2017b) (Young *et al.*, 1996)
SARS-CoV-1 (SARS)	Guangdong, China	November 2002-July 2003	Bat Civet cat Human	fever malaise myalgia headache diarrhea shivering cough and breath shortness	2-7	ACE2	Hunting, Dealers of wild animals in markets International travel	Butchers, Wildlife animal husbandry, Infected Research Areas	10.9%	(Hui *et al.*, 2020b) (Kakodkar *et al.*, 2020) (Lu *et al.*, 2020) (Chan *et al.*, 2020) (Li *et al.*, 2005) (Webster, 2004) (Guan *et al.*, 2003b) (Lim *et al.*, 2004) (WHO, 2015)
MERS-CoV (MERS)	Saudi Arabia	July 2012-2018	Bat Camel Human	fever cough and shortness of breath common cold chills headache joint pain	5	DPP4	International travel, contact with camels	Consumption of camel meat or milk	35%	(Skariyachan *et al.*, 2019) (Kakodkar *et al.*, 2020) (Zaki *et al.*, 2012) (Wang *et al.*, 2013) (Perlman and Netland, 2009) (Saeed *et al.*, 2017) (Shehata *et al.*, 2016) (Kandeil *et al.*, 2019) (CDC, 2020)
SARS-CoV-2 (COVID-19)	Wuhan, China	December 2019- Not controlled yet	Bat Pangolin Human	fever cough and shortness of breath	2-14	ACE2	sale of bush meat in seafood market	Fecal-oral path, Droplet transmission, Conjunctiva Fomites	4.9%	(Jin *et al.*, 2020) (Borba *et al.*, 2020) (Hui *et al.*, 2020a) (Ong *et al.*, 2020) (Zhang *et al.*, 2020) (WHO, 2020a)

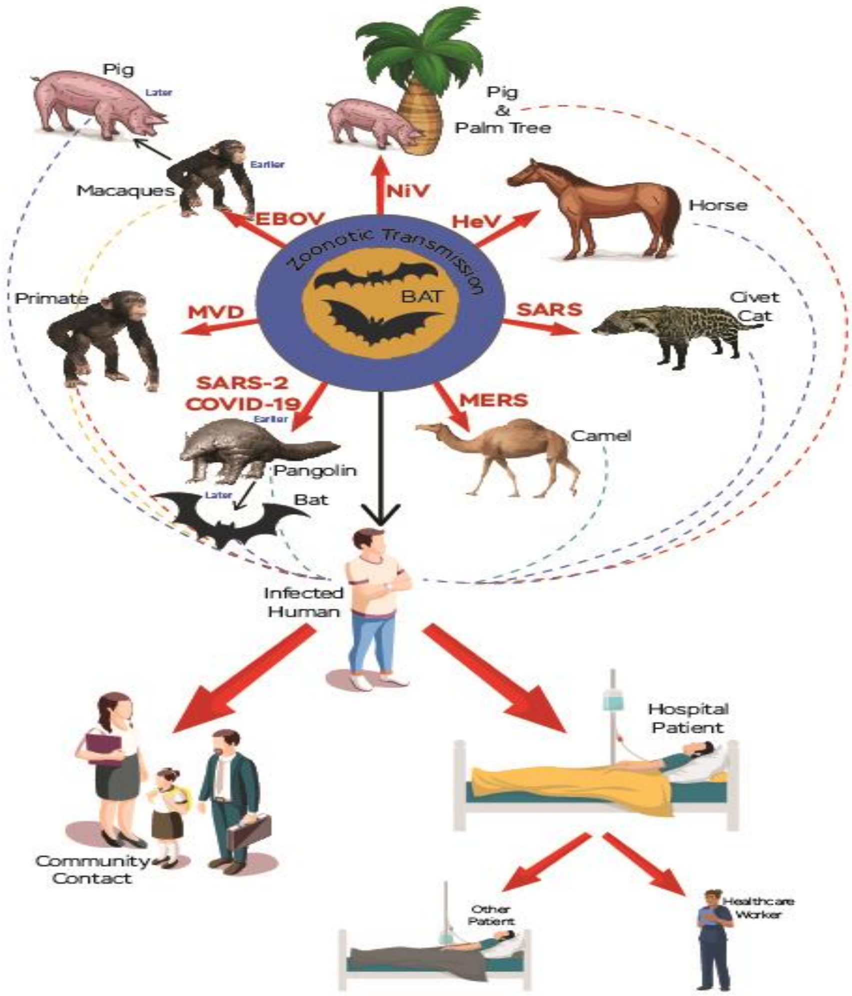

Figure 2: The mode of transmissions of viral pandemics/epidemics to the human population from different reservoirs is represented.