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Bioterrorism in the Twenty-First Century: Exploring the Threat of Potential use of Biological Weapons by Anti-State Agents

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A B S T R A C T

Bioterrorism involves the intentional dissemination of biological agents, such as bacteria, viruses, toxins, or fungi, with the aim of causing widespread fear, illness, and death among targeted populations. Anti-state agents, including terrorist organizations or individuals with extremist ideologies, may employ bioterrorism as a means to achieve their political, ideological, or religious objectives. The study explores the motivation behind the potential use of bioterrorism by anti-state agents, the threat of biological warfare, and the state readiness in the case of a biological attack. It examines the history of biological warfare, the factors that make biological warfare attractive to terrorist organizations including potential for mass casualties, psychological factors behind the attacks, access of biological agents, and the issues and challenges associated with detection, responses, and prevention of a biological attack by anti-state agents. The research used securitization theory to understand the phenomenon behind biological warfare. The study identified that despite the small scale of biological attacks in the past by anti-state agents, the threat has increased in the recent times as the technological advances and access to these agents make the people vulnerable to such attacks by the non-state actors . The study also concluded that strengthening global surveillance systems, enhancing public health infrastructure, and promoting information sharing among states and international emergency response services are vital in preventing and mitigating the impact of bioterrorist attacks.

INTRODUCTION

Bioterrorism refers to the deliberate use of biological agents, such as bacteria, viruses, toxins, or fungi, to cause harm and create panic among populations (Animals, Plants, Other living organisms) through air, water, and food to influence government policies or attacking civilian population. The disease is categorized by the Centre for Disease Control and Prevention (CDC) into Category A (can be transmitted from person to person, high mortality, and causes panic), Category B (Moderately easy to carry, low mortality rate) and Category C (Emerging pathogens, high mortality rate, major health impact). A wide range of biological agents can be employed in bioterrorism attacks. These agents can be categorized into three main groups: bacteria, viruses, and toxins including; Anthrax (Bacillus anthracis), Plague (Yersinia pestis), and Tularaemia (Francisella tularensis), Viral agents include smallpox (Variola virus) and viral haemorrhagic fevers (e.g., Ebola virus). Bioterrorism poses significant threats to public health and national security and could be a cause of global panic and distress. The release of a biological agent can lead to widespread illness, death, and panic and the potential for rapid transmission, high mortality rates, and the difficulty in diagnosing and treating certain diseases make bioterrorism particularly challenging to manage. Bioterrorism is aimed at causing causalities among the civilian population and provide public harm through spread of infection that is difficult to trace, and is intended to cause public fear and panic more than harming the majority of population.

The use of biological agents as weapons is an ancient phenomenon. Bioterrorism has been used in war and colonialization for over 2000 years through different sources like poisoning of water supplies during attacks and carries more than 1200 types of agents that could be used to create destruction. In recent times, the phenomenon, although dangerous, has been used only 0.02 percent in anti-state terrorism, and since the 1970, 33 biological weapons related terrorist attacks have been reported globally resulting in 9 deaths and 806 injuries. The attacks of similar nature in recent times included Anthrax attack (2001), SARS (2003), Swine Flu (2009), and Ebola (201415) sparked a new debate in what could be another series of biological attacks through anti- state agents.

This research aims to analyze and predict bioterrorism risks from specific groups based on their communications, so it is important to keep a watchful eye into the terrorist communities to watch for any event of acquiring and developing mass scale bioweapons. The research is developed in a way that an understanding could be established into finding ways of what are the possible interests and strategies that could lead anti-state agents into waging a bioterrorist attack. The research is intended to develop a framework in understanding the past events that resulted in bioterrorist attack, and recommend policy options for the policy-makers and the academic community understand the phenomenon in terms of its potential use by anti-state agents. The research is exploratory in nature using qualitative techniques on secondary data using PRISMA to find out the chances of bioterrorist attacks by the anti-state agents in future. Also, understanding the phenomenon behind the elements that incite the attacks of such nature. Also, the research focused on trying to find if any attack of such

nature was carried out by anti-state agents in the past to develop an understanding of its probability in future. Recommendations are provided in the end to help policy-makers and researchers develop an understanding and draft policies in light of the findings of the research. While a large-scale bioterrorist attack remains unlikely, the potential dangers necessitate vigilance and preparedness.

LITERATURE REVIEW

Bioterrorism

Bioterrorism is the use of biological agents illegally to cause deaths or harm to the animals, plants, and humans on a large scale while using small amount of toxins. Biological agents including bacteria, viruses, fungi, living microbes and their toxins, and insects, that are present in the natural habitat, could be genetically modified and used as a bio-agent to affect, spread disease, and kill people, and livestock, and damage crops. The features that make biological agents ideal for bioterrorism by anti-state agents includes its low cost, easy carriage, no destructive effect, difficulty in identifying the origin and controlling the spread, and lethal action that makes them a national security threat.

Biological warfare has been conducted for centuries in the past, and to date, there is no mechanism that is foolproof to detect and deter bioterrorist attacks despite the presence of international treaties. With the changing nature of threats, the emerging coercions include threats to state sovereignty, as well as climate change, global warming, and spread of diseases through genetic mutation that could impact humans. A research conducted by The College of Physicians of Philadelphia suggests that the threat of a biological attack is minimal, because of the preparedness issues on a large scale, cultivation, and deployment of the pathogens in the population. There is still a need to develop counter measures for prevention of the spread and mitigating the damages. Also, to study the response system and readiness of the emergency response services if there is a pandemic. There is a need to develop preventive actions, and early detection mechanism which could be implemented in case of a bioterrorist attack.

Olga Khokhlova et al in their study found that the spread of contamination on a mass scale has resulted in states changing their strategies to manage and control its flow, and has raised serious concerns at the state institutions on their preparedness to deal with them. [17] For instance, the states have become cautions of any spread of contamination, and start adopting measures to prevent further damage. Kayla Arnold further added that in wake of the coronavirus, the impact of Covid- 19 was viewed as far reaching that cautioned the “Council of Europe”, which noted that because of its contagious effects, the virus could be obtained and misused by the anti-state agents as a bioterrorism agent to cause destruction and disruption at a mass level.

Literature has listed the biological pathogens development programs in the twentieth century by the states, and there is much use of these weapons by the state agencies especially during the First World War (WW1) and cold war. In the twentieth century continuing till today, the biological programs are carried

out by state agencies, and evidences of state used biological capabilities have appeared. W Seth Carus and Charles D. Lutes studied those countries including China, Canada, Cuba, France, Germany, Iran, Italy, Iraq, Israel, Japan, Libya, North Korea, Russia, South Africa, Syria, US, and the United Kingdom that have or had an active biological pathogens development program. Realizing the threat of spread of biological weapons globally, many steps have been taken. For instance, an expert Penal of the scientists at the World Health Organization (WHO) developed a model in 1970, that if an aerosolized Y. pestis of 50kg is released on a population of five million would cause 150,000 people suffering from pneumonic plague, 36,000 deaths, spreading to 90 percent of population in the passage of 20-30 days, causing fatality at 6070 percent. As a result, many steps have been taken at state, national, and international level to contain the spread of bioweapons from falling into anti-state actors. In response to increasing the bioterrorism attack threat, Interpol has issued report on the increasing threat of bioterrorism by anti-state actors, reporting that the anti-state actors and terrorist groups have the capabilities of using bio agents for terrorist activities. A study by Carus and Lutes on obtaining and using biological agents by anti-state actors negates the possibility of a biological attack by the anti-state agents compared to other forms of attacks because of its complex and technical knowledge, acquisition difficulties as they are controlled by state entities, and lack of interest in further development by the states on ethical basis.

Categories of Bioterrorism Agents

The center of Disease Control and Prevention (CDC) has categorized biological agents into three categories based on the nature of the pathogens they possess, and the damage that could be created through its impact. The impact of these categories of virus spread varies with Category A with the highest to moderate impact, spreading in public and causing sickness, Category B with moderate impact, easy to transmit but low causalities, and Category C, are genetically engineered, has long-term effect with high mortality rate, and is highly toxic.

History of Bioterrorism (Pre 1900s)

Historically wars have been fought with swords, but with the advent of technology, the trends have developed, changing the course of wars to nuclear weapons, chemical weapons, cyber threats, and biological warfare. Samuel Paik (2023) in his research described that bioterrorism has its roots dating back to pre-Christian era when the traditional wars were fought with horses and swords making it one of the earliest forms of terrorism rather than a new phenomenon. Zainab et al (2021), further added that in order to achieve the upper hand over the enemy, one of the ways developed is through the spread of diseases that seem to be the most convenient way to weaken the enemy. The history of biological attacks by the nations and the institutions, as well as individuals dating back from pre-1900s till the known history are displayed in the Table 2.3 below.

Table 2.3: Biological Attacks in history pre-1900s.

YEAR	USER	PATHOGENS	PURPOSE
1155*	Emperor Barbarossa (Italy)	Human Bodies	Poisoning of water wells.
1336**	Mongols	Bubonic Plague	Attack population during war with infected victims.
1495*	Spanish	Blood of Leprosy Patients.	Sold to French enemies in Wine in Italy.
1650*	Poland	Saliva of Rabid dogs	Fired the saliva on the enemies.
1710***	Russians	Plague infested Corpses	Swedish Forces
1763**	British Officers	Small Pox	Used on native Americans.
1785**	Tunisia	Plague	Tainted clothes during siege of La Calle.
1797*	Napolean	Malaria	Through flooding plains in Italy.
1863*	USA	Yellow fever & Small Pox	Through distribution of infected clothes.

Source: EMBO Press.

**Source: History of Vaccines.

***Source: Encyclopedia Britannica.

Bioterrorism: Since Twentieth Century

The use of bioweapons, and bioterrorism is still recorded in the twentieth, and twenty-first century despite efforts being made to contain the use of biological weapons, and toxins globally. Frischknecht (2003) found out that despite the two declarations signed in the nineteenth century, 1874 Brussels, and 1899, in the Hague, it could not prevent the use of bioterrorism in the world, and incidents including the use of biological and chemical weapons by Germany in WW1, and Japan in WW2. Nicolas Schillinger (2023) further added that the Chinese government accused US of using biological warfare in the Korean war using Anthrax, and plague in Korea, and North East China. Although the threat of biological warfare remains low by the anti-state agents, the use of biological weapons has largely been accredited to the state-backed programs that initiated and controlled the biological activities around the globe as demonstrated in (Table 2.4).

Table 2.4: *Bioterrorist Attacks Twentieth Century- Till Date*

YEAR	USER	PATHOGENS	PURPOSE
1940s*	Japan	plague-infected fleas	Dropped on Chinese population through airplanes.
WW1**	Germany	Infection of Glanders	Infected horses and cattle owned by Allied Forces.
WW2*	Japan	Cholera and Shigella	Used in water wells on civil population in China.
WW2**	Japan	Bubonic Plague, Anthrax, Typhus, Smallpox, Yellow Fever, Tularemia, Hepatitis, Cholera, Gas gangrene, and glanders.	More than 3000 humans including Allied Forces.
1949-69*	United States	Anthrax and Botulinum toxin. Aspergillus fumigatus, Bacillus subtilis var globigii, and Serratia marcescens.	Tests were conducted in different cities causing urinary tract infections in the people in the US.
1978****	Bulgarian secret services	Toxic Ricin injected in leg through pallets. Known as "Umbrella Killing".	Attack directed towards Bulgarian citizen Georgi
			Markov in London and Vladimir Kostov in Paris.
1979*	USSR	Anthrax released in Russian city Ekaterinburg.	Accidental release in lab. Affected residents, and killing livestock in the radius of 50 Km.
1970-80s.**	Vietnam and Laos	Trichothecene toxins (Yellow Rain).	Used against Hmong tribes in Laos.

1979****	Iraq	B. anthracis, botulinum toxins, and Clostridium perfringens.	Iraqi government is accused by UN of using biological weapons against civilians. No concrete evidence has been found so far.
2001*	US	Anthrax (Spread by bio-defense researcher Bruce Ivins).	Mailed to senators, and media houses in US. 5 dead. 17 ill. 1727 exposed people.
2016***	Unknown	Anthrax	Death of 2350 Reindeers, and one human in Siberia. 5 adults diagnosed.

*Source: History of Vaccines
**Source: Encyclopedia Britannica.

Bioterrorism: Potential Agents

With the advancement in the field of biomedical, the potential threat of bioterrorism continues to increase. Rubina Ali (2021) wrote that having over 1200 forms of bioterrorism agents being discovered, the use of these agents could vary from small scale attacks, to creating destruction, or panic at state level. Bioterrorism agents range from their use on animals, plants, and humans, and also have different threat levels. With different threat levels, some of the potential bioterrorist agents that have been used in the past on a mass scale, and have a potential of use in future anti-state bioterrorist activities are discussed here.

- **Ebola Virus**

  According to the Centre for Disease Control and Prevention, Ebolavirus include, Zaire ebolavirus, Sudan ebolavirus, Taï Forest ebolavirus, Bundibugyo ebolavirus, Reston ebolavirus (affecting non-humans like pigs), and Bombali ebolavirus (still under study) discovered initially in 1970 in Democratic Republic of Congo, and South Sudan. The origin and carrier of the virus is known to be a bat, and is transmitted from animals to animals, with potential transfer to humans, which can make them sick, and transmit the virus to others through touch, or with bodily fluids.

- **Anthrax**

  Anthrax or Bacillus anthracis according to CDC is one of the most toxic biological weapons that could be used in biowarfare because of its resistance and survival properties in

the natural environment and its potential as a deadly disease. The agents in Anthrax are resistant to heat, radiation, pressure, and disinfectants which makes them ideal for attacks on humans as well as animals and be used as a biological weapon. Ashiq et al., (2023) found that the nature of Anthrax attacks could vary, and are directed towards humans, as well as farming animals, and despite the treatments available for the disease, the potential toxic nature of the biological agent makes it ideal for attacking humans civilian and military installations and be used as a biological agent by the terrorists and anti-state agents.

- **Small Pox**

  Small pox is an infectious disease that is carried by the biological agent Variola Virus which is believed to have been eradicated in 1980 as a result of vaccination and cure available on a mass scale. Smallpox has been categorized as the deadliest disease in the eighteenth century with its uses in traditional warfare as a biological weapon has been known to prevail, for instance, its use by the British army troops on native Americans that caused mass scale deaths. Small pox has been eradicated as a biological agent through treatment, but a toxin type of small pox "Variola Virus (VARV)" still has the potential to be used as an agent of biological warfare. Although the treatment is available, the fear factor of the mass spread of the virus still remains at large as it could be used as a biological weapon by the anti-state agents to create mass fear in the public and create mass emergencies.

- **Plague**

  Plague or *Y Pestis* is a toxin that causes illness, and even death, and spreads through fleas, or through an infected organism, and exists in nature, and could be lab grown with the potential of infecting a large population which makes it a potential biological weapon, for instance a pneumonic plague spread through aerosols. Plague has been known as "Black Death" and has caused millions of people to die, for instance the first plague resulted in 10,000 deaths per day in 542 A.D., the black death pandemic that attacked the Eurasia, resulting in 25-75 million deaths, in the second plague in 1334, and the "Great plague of London" in 1665 killing 70,000 residents.

- **Glanders**

  Glanders is traditionally a botanic disease that is common in horses, mules, and asses, and could be transmitted through them and could infect humans that handle the

infected animals causing serious health risks. Glanders that was removed from United States and Europe has started to emerge again in Western Asia, North India, and South America, and has a potential of a bioterrorism agent because of its high mortality rate.

Bioterrorism Treaties

Biological pathogens have been used as a bioterrorism weapon in the past in military, as well as on the civilian population. In the nineteenth century, when the spread of bioterrorism increased in the military weaponry, governments around the world came together and signed treaties that could ensure that the impact of biological warfare could be contained. With rapid advancement in the field of biology and biosciences, the threat of biosecurity, and bioterrorism has increased in recent times, due to which countries that are capable of biotechnology have collaborated to sign agreements for containment and control of their biotechnology. This has been in light of the threats the anti-state agents have posed to the controlled programs, and the threats which could be posed by these agents in the event of spread of the biotechnology in the hands of terrorists, and anti-state actors. The treaties are detailed under;

- **Geneva Protocol (1925)**

  As a result of use of biological weapons in the first world war, and preceding events, many nations came forward to sign a joint agreement to prohibit the use of chemical, and biological weapons in peace and war time. The treaty was signed and was known as Geneva Protocol. The "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases and of Bacteriological Methods of Warfare" or Geneva Protocol was signed in 1925 and prohibits the use of chemical gases and biological agents during the war time. [47] The protocol has been ratified by 65 states, has 146 parties, and thirty-eight signatories, and is the upgradation of the Hague Convention 1899, and after amendments in the terms of the treaty, is accepted as general law under the United Nations conventions of the control of chemical and biological weapons.

- **The Biological Weapons Convention (BWC) 1972**

  The Biological Weapons Convention (BWC), under the United Nations is a legally binding contract to spread the control of biological weapons that came into force from March 25, 1975, and has currently 183 countries as its signatories. The treaty binds the member nations from using biological agents or testing them on humans, and is a platform where the threats from biological weapons is routinely discussed, and preventive controls are suggested, although it

implementation has become weak with the passage of time.

Bioterrorism and Anti-State Agents

Bioweapons have been used by anti-state agents in history, and have a potential use in the future by the non-state actors as studied by the literature. The use of biological pathogens poses threat of the individual states, medical health emergency organizations, and international organizations. The use of biotechnology in the field of sciences has advantages, as well as the disadvantages that include the misuse of technology either willingly, or unwillingly, and brings with it dual security risks that need to be realized by the states, and international authorities. Although the threats posed by anti-state agents are very rare compared to state sponsored activities in the last century, some of the incidents that have taken place since 1970's involving anti-state agents and natural contamination of the biological hazard that could attract these non-state actors is detailed in the table 2.7 below.

Table 2.7: *Bioterrorist attacks by Anti-state actors since 1970*

YEAR	Anti-State Agent	PATHOGENS	PURPOSE	Affected
1978*	Bulgarians believed to be from secret services.	Plant toxin ricin (Famously known as umbrella killing).	Assassination of Georgi Markov, Bulgarian exile, and attempted assassination of Vladimir Kostov.	First target was killed, while the latter was hospitalized with serious injuries.
1984s*	Followers of Indian guru Bhagwan Shree Rajneesh. US	Typhoid	Used in a salad bar to influence local population in US.	800 people sick, 43 hospitalized, No one death.
1990-95**	AUM Shinrikyo sect. Japan.	Anthrax, botulinum toxin/ Sirin gas.	10 attacks on US bases in Japan/ Tokyo subway	Unsuccessful attacks.
2001*	US bio defense researcher Bruce Ivins.	Anthrax	Mailed to senators, and media houses in US.	5 dead, 17 ill, 1727 exposed people.

2014-16***	Natural spread but raised the alarm for use as a biological agent.	Ebola Virus	Spread through bats affecting 10 countries globally.	28,652 cases of Ebola with 11310 deaths in Guinea, Liberia, and Sierra Leone.
1990-2011***	Multiple source	Multiple agents	74 separate incidents of bioterrorism	The victims were civilians.

*Source: History of Vaccines
**Source: Encyclopedia Britannica.
*** Source: Centre for Disease Control and Prevention

METHODOLOGY

This research is based on interpretivist philosophy as the data collected is interpreted in depth and there was a small sample of data upon which the investigations were being made by the scholar. Based on the nature of the data and intended outcome, the researcher adopted the deductive research approach. The research is qualitative in nature and mono-method. The choice of selection of qualitative research method is motivated by the in-depth analysis of the available data through secondary sources, along with studying patterns that are difficult to explain in numbers which could be explained more through qualitative methods. As qualitative research provides an in-depth analysis through different strategies and techniques including archival research, and identify the patterns in previous research in case of secondary data collection, the method was selected by the researcher. Also, qualitative research could benefit more in potentially finding the unexplored areas and highlighting the potential research gaps, and guiding future research.

RESEARCH RESULT AND DISCUSSION

A research study was conducted on bioterrorism, its forms, motivation behind biological warfare by non-state actors, its chances in the future, and what are the ways in which state can counter the threat of biological attack by the anti-state actors. The research was aimed at finding the reasons behind anti-state agents conducting a biological attack in future, and the motivation behind such attacks. The research was also aimed at finding the chances of biological warfare in future, and what is the state of preparedness of states, and emergency services in this regard. In order to reach a conclusive result, the study used fourteen articles and reports analysed through PRISMA, and then content analysis was performed on these documents. The study was conducted in light of the securitization theory which helped in developing an understanding of how the threat of bioterrorism is constructed and how it influences security policies

and responses. The theory also helped in understanding the reasons behind a biological attack by the non-state actors, and what are the factors that trigger a response by the states and emergency services to control a biological activity.

The first research objective the drove the study was to find out the objectives behind nonstate actors using biological weapons to achieve their objectives. To find an answer to that, the research firstly found out what biological warfare is, and what are the biological agents that could be potentially be used as biological weapons. The study found out that the common definitions of bioterrorism included use of pathogens, viruses, and lab generated agents against humans, and animals with the intent of causing harm. The study also found out that the most common pathogens or toxins that have been used in biological warfare, and have the potential to be used by the nonstate actors included Anthrax, Ricin, Botulinum toxin, Small pox, plague, and Ebola Virus. Because of the deadly nature of these pathogens, and their easy availability due to its presence in nature makes it ideal for conducting biological attack. These biological agents have been categorized into different levels depending upon their use, toxicity levels, and the cure available in case of a biological attack. The results found by our research displayed that are congruent to previous systematic literature reviews including; (Beale et al., (2021); Sameul Paik (2023); Tulsi Chugh (2019); and Zhao et al., (2023).

In the next step, the motivators behind using biological agents by the non-state actors was analyzed from these articles. The study found out that the major motivators behind the spread of bioterrorism include the spread of chaos in a society, economic and political factors, mass casualties, its easy access due to technological advancement, religious extremism, inciting terror, and psychological warfare. As the primary motivators of the anti-state agents is spread of fear, and damage to the societies and states, bioterrorism provides a platform for these non-state actors to conduct their operations in order to bring instability to the state and global system. This was also found to be in line with previous systematic literature reviews including; Borio et al., (2015); Lauren Wilson (2023); Pilch et al., (2017); and Santarpia et al., (2023).

The researcher found that bioterrorism is an ancient phenomenon that has been used by states and non-state actors in the past since ancient times. The toxins, and bacteria that are present in the atmosphere, and could potentially be transmitted through animals, and genetic modification in the labs could be used as a biological weapon. The interest of non-state actors, and terrorist organizations is the mass scale terror, and psychological warfare that is their primary motivation to get involved in the use of these pathogens and viruses. Anti-state agents find the biological agents as a feasible replacement to the conventional ways of terrorist attacks using weapons. With the advancement in the field of biomedicine, the toxic levels of these agents have been modified to give maximum damage to the human and animal population. This makes these agents ideal for its use in a warfare and anti-state agents have been trying to obtain these toxins for a while in recent times.

The reason for use of biological toxins is also its low cost, ease of access of these agents due to its presence in the nature, ease of production in a controlled

environment and delivery of these agents to the public without having to fear about its detection. The attraction of these traits makes biological warfare a target for future warfare that is aimed at causing mass scale fear, and psychological attacks that can cause social anxiety and economic disruption on a large scale at national as well as international level.

The next research objective of the study was to find out about the chances of biological warfare in future. The study found out that the chances of the biological warfare in future, are rare, but they are present. In case of a biological attack, there are advancements in biotechnology that could counter such attacks and contain them on a small scale. But the chances of acquiring these pathogens, and using them by the anti-state agents are increasing because of the technological advancements, and the use of digital forums, that could help these terrorist organizations, and antistate actors to grow these agents with ease. Although the issues with establishment of a facility that could generate biological toxins are present which makes it difficult for the anti-state actors to acquire them and prepare these agents on a large scale, the small-scale preparedness of these agents is still possible, which makes the societies vulnerable to these attacks in future. The research found out that the chances of these events occurring are very minimal due to advancement and biosecurity measures, that makes the acquisition, and use of these pathogens very rare.

The studies also found out that biowarfare has been associated in the past mostly with state actors that have used it on the other states especially during the world wars in the last century that saw its increased usage as compared to non-state actors. Most of the incidents in recent times also occurred due to the accidental release of these harmful pathogens from the state-controlled labs after which different countries around the world reached conclusive agreements to eliminate the use of these agents on other states. The production of biological agents, however, still remains a question. This is in line with the systematic reviews, and analysis done by other researchers including; Bhatia and Sandhu (2019) [63] ; Orlando Cenciarelli et al., (2019) [64] ; Green et al., (2019)[65]; Maxson et al., (2022)[66]; and Mir et al., (2022)[67].

The last research objective was related to the research question on what are the preparedness levels of government and state agencies in the event of bioterrorism. The outcome of the research was divided into two segments. One being the preparedness levels of the emergency health services that comprise of national as well as international medical emergency responses. The other part comprised of the biological preparedness by the government agencies against containment, and spread of the toxins, and stopping its potential reach and use by the anti-state agencies. In terms of preparedness by the emergency services, the study observed that the articles under analysis discussed issues like advancement in the vaccines, and treatments that are taking place over time, the lack of equipment with many response teams, and adequate measures to contain the spread of disease in certain cases. These studies also discuss issues like advancement in bioterrorism, and the lack of biological preparation by the emergency teams, that have been worrisome for the emergency teams. Also, on the other hand, there are medical advancements that are taking place globally to

contain the new threats by preparing emergency responses by the teams.

Previous researches on hospital and emergency responses teams' readiness including Antunes et al., (2022)[68]; Ashima Jha (2023)[69]; and Koch et al., (2020)[70]; also discussed the same issues that the medical staff is facing. Also, there is a lack of coherence globally on the methods and treatments that are available to stop the spread of biological attack by the terrorist organizations. There are other issues identified in the research including training and development of the medical and emergency health staff, awareness of biological attacks by the emergency staff, as well as the public, and lack of communication which cause serious threat to increased damage that could potentially be caused in the event of biological warfare. This is also reported by Wrigley et al., (2003). Research by Kman & Nelson (2008) also reported the same results that it is very vital that the emergency response teams including doctors, nurses, and emergency staff be well equipped, and trained to fight the bioterrorist attack in case there is another incident in future. The current study also stresses the importance of emergency staff preparation, and hospital equipment to deal with issues around the world. In terms of readiness of the state agencies and departments, the study through content analysis found that there is a need to enhance the existing state response against any potential biological warfare from the anti-state agents. There is a need to build health emergency perimeters by the government, ways to increase mass awareness of the issue should be adopted by the state departments to increase awareness among the people. Syndrome surveillance, and reporting mechanisms that have been built over the past should also be updated to respond to the current threats of bioterrorism.

Also, the study found that with advancement in the digital technologies, there is a threat of ease of access to biological agents and its preparation, that should be catered by building a detection mechanism into the cyber activities related to bioterrorism. There is also a need to develop robust infrastructure and international collaboration that could be effective if there is an event in the future as the current system needs further upgrade. This is in line with the past studies on systematic review including Bullock et al., (2021) and Bourrier & Deml (2022) in which the latter study discussed in detail on the state and international level preparedness in response to global pandemics like Covid-19. The latter study suggested that the global pandemic outbreak has posed serious questions on the state preparation in case of a global health emergency including bioterrorism. Our research also found the same responses that although the state mechanism to fight bioterrorism exists in majority of the countries, and with global medical health response teams the process exists that could contain any such threat. There is however, a need to upgrade these responses and preparations in light of the recent events that could incite the anti-state agents to conduct a mass scale bioterrorist activity considering its outcomes and contamination effects.

CONCLUSIONS AND RECOMMENDATIONS

Bioterrorism is an ancient threat that has been exercised by different state and non-state actors since the ancient times. In the twenty-first century, the activities of anti-state agents are on the rise globally. This poses a major threat to the global security. One of these threats is biological warfare. This study was

conducted with the aim of understanding the biological agents, the motivation of using these agents by the non-state actors, and preparedness of the state agencies and global health institutions in the event of a biological attack. It is concluded that with the current technological advancement, there are certain vulnerabilities including biological warfare that have given rise to global threats by these anti-state agents. It was found in the study that biological toxins, and bacteria that is present in nature, could be used through spread of contamination, and genetic modification of these natural agents which makes them a threat to global health. Bioterrorism can pose serious threat to life, economic activities, psychological warfare, and a source of mass casualties. These properties of biological toxins, and plagues makes these agents ideal for use by the anti-state agents. Although the chances of a mass-scale biological warfare are rare because of the advancement in treatments, and vaccinations, the threat still remains at large. Therefore, it is vital that the states should plan for an effective and timely response towards these anti-state activities carried out by terrorist organizations

In light of the findings of the research, following policy implications are suggested by the researcher:

- There is a need of strong policy-making on national and international level against the preparation, and use of biological agents by the states, and new treaties are needed for further spread of these agents whether on purpose of by accident.

- There is a need to create awareness among the public on potential biological attacks, and how to respond in case of such emergencies.

- There is also a need to upgrade the emergency responses especially in the developing countries so that their spread could be contained on a small scale in case of an event.

- There is a need to upgrade the training and development of the emergency medical staff so that they are equipped against biological warfare.

- There is also a need to check the cyber use of anti-state agents that try to acquire the biological agents through online activities.

- Global data related to biological hazards, and state-controlled activities should be maintained for the betterment of the society.

ADVANCED RESEARCH

In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves.

Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

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