

Conventional and Non-Conventional Warfare

Biological and Chemical Weapons: Contemporary Threats and Responses

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Abstract: Biological and chemical weapons (BCW) pose significant contemporary threats to global security, as advancements in science and technology have made their proliferation more feasible. This paper examines the evolving landscape of BCW threats, including state and non-state actors' capabilities and motivations. It highlights key incidents and case studies that illustrate the potential for devastating impacts on civilian populations and ecosystems. Furthermore, the paper analyzes international treaties and response mechanisms, such as the Biological Weapons Convention and the Chemical Weapons Convention, assessing their effectiveness in preventing the use of BCW. The findings underscore the need for enhanced global cooperation, stricter enforcement of regulations, and innovative strategies to mitigate risks associated with these weapons.

Keywords: Biological Weapons, Chemical Weapons, Global Security, Non-State Actors, Proliferation, International Treaties, Response Mechanisms

Introduction: Biological and chemical weapons (BCW) have emerged as critical threats to global security, representing a unique class of armaments that can inflict mass casualties and widespread panic. These weapons have a long history, with documented uses dating back to ancient warfare. However, the contemporary landscape is characterized by a significant evolution in the nature of BCW threats, driven by advancements in science and technology, changes in geopolitical dynamics, and the increasing capabilities of non-state actors. The World Health Organization (WHO, 2020) highlights the growing risk posed by biological agents, particularly in an era marked by globalization and interconnectedness. Historically, chemical weapons have been utilized in various conflicts, most notably during World War I, where they caused unprecedented suffering and loss of life. Following the war, the international community recognized the need for regulation, leading to the establishment of the Geneva Protocol in 1925, which prohibited the use of chemical and biological weapons (Crawford, 2019). However, the reality is that these weapons continue to be developed and used, with several states possessing stockpiles and non-state actors increasingly capable of deploying them. The rise of non-state actors, particularly terrorist organizations, has added a new dimension to the threat posed by BCW. Groups such as ISIS and Al-Qaeda have expressed interest in acquiring chemical and biological agents for use in attacks, raising concerns about their ability to cause mass casualties and instill fear in civilian populations (Bunn, 2017). The potential for these groups to employ BCW in urban environments amplifies the risk, as the effects of such attacks could be catastrophic, not only in terms of immediate casualties but also in terms of long-term public health implications. Recent events have underscored the importance of addressing the challenges associated with BCW. The use of chemical weapons in the Syrian Civil War has drawn international condemnation and highlighted the failure of existing regulatory frameworks to prevent their use (United Nations, 2018). Similarly, the COVID-19 pandemic has exposed vulnerabilities in global public health systems and demonstrated how biological threats can cross borders and disrupt societies on a massive scale (Paltiel et al., 2020). The pandemic has illustrated that biological agents can be employed, intentionally or unintentionally, to cause widespread fear and chaos,

Conventional and Non-Conventional Warfare

thereby affecting global stability. The international community has sought to address the risks posed by BCW through various treaties and agreements. The Biological Weapons Convention (BWC), established in 1972, aims to prohibit the development, production, and stockpiling of biological weapons (ElBaradei, 2016). Similarly, the Chemical Weapons Convention (CWC), implemented in 1997, prohibits the use of chemical weapons and requires states to destroy existing stockpiles. Despite these efforts, the effectiveness of these treaties has been called into question, particularly in light of ongoing violations and the challenges associated with enforcement (Cohen, 2021). One of the primary challenges in effectively addressing the threat of BCW is the difficulty of attribution. Identifying the perpetrator of a biological or chemical attack can be complex, particularly in environments where multiple actors are involved. This lack of accountability complicates response efforts and undermines deterrence (Sullivan, 2019). Additionally, the dual-use nature of many biological and chemical agents—meaning they can be used for both legitimate and malicious purposes—adds to the complexity of regulating these substances (Graham, 2017). In light of these challenges, there is an urgent need for enhanced global cooperation and innovative strategies to mitigate the risks associated with BCW. Strengthening existing international frameworks, improving verification mechanisms, and fostering collaboration among states, non-governmental organizations, and the private sector are essential steps in addressing the evolving threats posed by biological and chemical weapons. Moreover, investing in research and development to improve detection, response, and recovery capabilities is critical to minimizing the impact of potential attacks (WHO, 2021). This paper aims to provide a comprehensive analysis of the contemporary threats posed by biological and chemical weapons, focusing on the motivations and capabilities of state and non-state actors. It will explore key incidents that illustrate the potential impact of BCW on civilian populations and the environment. Furthermore, the paper will evaluate the effectiveness of existing international frameworks in mitigating these threats and propose recommendations for enhancing global cooperation and regulatory measures. As the landscape of warfare continues to evolve, addressing the challenges posed by BCW is imperative for safeguarding public health, security, and global stability.

Literature review:

The literature on biological and chemical weapons (BCW) is extensive and multifaceted, reflecting the complexity of these threats and the challenges they pose to global security. This review synthesizes key themes and findings from various studies that highlight the contemporary landscape of BCW threats, the motivations behind their use, and the effectiveness of existing regulatory frameworks.

Historically, biological and chemical weapons have played significant roles in warfare, with their use documented as far back as ancient times. During World War I, the deployment of chemical agents such as chlorine and mustard gas marked a turning point in military tactics, leading to widespread suffering and casualties (Crawford, 2019). Following the war, international efforts to regulate these weapons resulted in the Geneva Protocol of 1925, which prohibited their use. However, the lack of enforcement mechanisms rendered the protocol ineffective in preventing future uses of BCW (Morrison, 2017).

Recent conflicts, particularly in the Middle East, have reignited concerns about the use of chemical weapons. The Syrian Civil War has been particularly notable for the repeated use of chemical agents, including sarin and chlorine gas, raising questions about the effectiveness of international treaties in preventing such violations (United Nations, 2018). Studies suggest

Conventional and Non-Conventional Warfare

that the resurgence of BCW in contemporary conflicts can be attributed to the weakening of international norms and the increased capabilities of non-state actors (Hoffman, 2015).

The motivations behind the use of biological and chemical weapons are complex and varied. State actors may resort to BCW as a means of achieving military objectives, deterrence, or political leverage (Arkin, 2018). For instance, the use of chemical weapons by the Assad regime in Syria was partly driven by the desire to maintain power and control over opposition forces (Graham, 2017). In contrast, non-state actors, including terrorist organizations, may view BCW as tools for mass disruption and psychological warfare. The potential to cause fear and panic among civilian populations makes these weapons appealing to groups such as ISIS and Al-Qaeda (Bunn, 2017).

Research indicates that the motivations for employing BCW are often influenced by perceived effectiveness and accessibility. Non-state actors may prioritize easily attainable agents, such as toxic industrial chemicals or pathogens, over more complex biological weapons (Gottlieb, 2020). This trend raises significant concerns about the proliferation of dual-use technologies and the potential for malicious exploitation in a variety of contexts.

The international community has established several treaties aimed at preventing the proliferation and use of BCW. The Biological Weapons Convention (BWC), adopted in 1972, seeks to prohibit the development, production, and stockpiling of biological weapons. Similarly, the Chemical Weapons Convention (CWC), implemented in 1997, aims to eliminate chemical weapons entirely (ElBaradei, 2016). Despite these frameworks, the effectiveness of the BWC and CWC has often been called into question.

Critics argue that both treaties suffer from significant enforcement challenges. The BWC lacks verification mechanisms, making it difficult to ensure compliance and accountability (Pérez, 2018). The CWC, while more robust in its verification provisions, has faced challenges related to the detection of clandestine programs and the handling of non-compliance by member states (Cohen, 2021). Additionally, the rapid technological advancements in the life sciences and chemistry present new challenges for regulating dual-use research and ensuring that legitimate scientific endeavors do not contribute to the development of BCW (Graham, 2017).

The emergence of new technologies poses additional challenges for managing BCW risks. Advances in biotechnology, such as gene editing and synthetic biology, have the potential to revolutionize medicine and agriculture. However, they also raise concerns about the unintended consequences of these technologies, including their potential use for malicious purposes (Sullivan, 2019). Research suggests that the accessibility of biotechnological tools may enable both state and non-state actors to develop novel biological agents that could be weaponized (Naylor, 2020).

Moreover, the COVID-19 pandemic has highlighted the interconnectedness of biological threats and global health security. The pandemic demonstrated how rapidly infectious diseases can spread across borders, leading to severe public health crises and significant socio-economic impacts (Paltiel et al., 2020). As nations grapple with the fallout from the pandemic, discussions about biosecurity and preparedness have gained prominence, emphasizing the need for enhanced global cooperation and innovative response strategies (WHO, 2021).

The literature on biological and chemical weapons underscores the complex interplay of historical context, motivations, and regulatory frameworks that shape contemporary threats. The ongoing use of BCW in conflict zones, coupled with the rise of non-state actors and technological advancements, necessitates a re-evaluation of existing policies and strategies.

Conventional and Non-Conventional Warfare

Moving forward, it is crucial to enhance global cooperation, strengthen regulatory mechanisms, and invest in research to mitigate the risks associated with BCW. As the landscape of warfare continues to evolve, addressing these challenges will be imperative for safeguarding public health, security, and global stability.

The evolution of biological and chemical weapons is rooted in both technological advancements and historical conflicts. Scholars note that while the use of BCW has been curtailed by international treaties, the reality remains that many states continue to develop and maintain these arsenals. According to McLeod (2021), the end of the Cold War and the subsequent rise of rogue states have led to a resurgence in BCW development, particularly in regions where state control is weak. For example, the proliferation of chemical weapons in the Middle East has become a pressing concern, with reports indicating that both state and non-state actors possess such capabilities (Falk, 2020).

Moreover, the implications of bioweapons have evolved with the increasing accessibility of biotechnology. Many researchers point to the 2001 anthrax attacks in the United States as a pivotal moment that heightened awareness of the bioweapons threat, leading to renewed focus on the potential for non-state actors to employ such tactics (Bunn, 2017). This incident sparked significant research into biodefense and public health preparedness, demonstrating the intertwined nature of health security and national security (Morrison, 2017).

Understanding the motivations behind the use of BCW is critical for assessing the risks they pose. Research indicates that states may use BCW to achieve strategic military advantages, deter adversaries, or exert political pressure (Arkin, 2018). For instance, states such as Syria have utilized chemical weapons against their own populations to suppress dissent and maintain control over territory, showcasing the brutal potential of these weapons in internal conflicts (Graham, 2017).

Non-state actors, on the other hand, often view BCW as tools for asymmetric warfare. Scholars like Cottam (2020) emphasize that terrorist organizations may resort to these weapons to provoke fear and chaos, leveraging the psychological impact of such attacks to further their ideological objectives. The potential for catastrophic effects and the ability to exploit vulnerabilities in public health systems make BCW an appealing option for groups seeking to disrupt societal stability (Hoffman, 2015).

The international community's efforts to mitigate the risks associated with BCW through treaties like the Biological Weapons Convention (BWC) and the Chemical Weapons Convention (CWC) are crucial areas of study. While these treaties represent significant milestones in disarmament efforts, their effectiveness has often been challenged. Scholars argue that the lack of robust enforcement mechanisms and verification processes has led to gaps in compliance and accountability (Cohen, 2021).

A critical analysis by Pérez (2018) highlights that while the CWC has more comprehensive verification provisions, challenges remain in detecting clandestine programs. In contrast, the BWC's lack of formal verification mechanisms has resulted in widespread concerns regarding compliance among signatory states (McLeod, 2021). Furthermore, the growing prevalence of dual-use technologies complicates regulatory efforts, as legitimate scientific research may inadvertently contribute to the development of BCW (Graham, 2017).

The rapid advancement of technology, particularly in biotechnology and synthetic biology, presents new challenges for managing BCW risks. Emerging research in gene editing and synthetic biology opens new avenues for both legitimate medical and agricultural applications, as well as malicious uses (Sullivan, 2019). The accessibility of biotechnological

Conventional and Non-Conventional Warfare

tools increases the risk that non-state actors will exploit these advancements to develop novel biological agents that could be weaponized (Naylor, 2020).

Moreover, the implications of the COVID-19 pandemic have reshaped the discourse on biological threats. The pandemic underscored the vulnerabilities in global public health systems and illustrated how quickly biological agents can spread, causing significant health crises and societal disruption (Paltiel et al., 2020). Scholars have called for a more integrated approach to biosecurity, emphasizing the need for collaboration between health authorities and security agencies to effectively manage biological threats (WHO, 2021).

Research Questions:

1. What are the primary motivations behind the use of biological and chemical weapons by state and non-state actors in contemporary conflicts, and how do these motivations influence the choice of specific agents and tactics?
2. How effective are current international regulatory frameworks, such as the Biological Weapons Convention and the Chemical Weapons Convention, in preventing the proliferation and use of biological and chemical weapons in the context of modern warfare?

Research problems: The research problem centers on the persistent threat of biological and chemical weapons (BCW) in contemporary warfare, driven by state and non-state actors. Despite existing international regulations, challenges in enforcement, compliance, and technological advancements hinder effective prevention and response, necessitating a deeper understanding of motivations and the effectiveness of current frameworks.

Significance of Research: Research Objectives: This research is significant as it addresses the evolving threats posed by biological and chemical weapons, emphasizing the need for improved regulatory frameworks and international cooperation. Understanding the motivations behind BCW use and assessing current policies can enhance global security, public health preparedness, and response strategies in an increasingly complex geopolitical landscape..

Research Methodology:

This research employs a mixed-methods approach to analyze the contemporary threats posed by biological and chemical weapons (BCW) and evaluate the effectiveness of existing regulatory frameworks. The quantitative component involves a systematic review of existing data on incidents of BCW use, gathered from reliable sources such as government reports, academic articles, and international organization databases. This data will be analyzed using statistical software to identify trends, patterns, and correlations between the use of BCW and factors such as geopolitical context, state behavior, and non-state actor involvement. The qualitative component comprises interviews with experts in international security, public health, and biodefense, providing insights into the motivations behind BCW use and the perceived effectiveness of current regulations. These interviews will be semi-structured, allowing for in-depth discussions while maintaining a consistent framework for comparison. Thematic analysis will be used to identify common themes and perspectives. Additionally, case studies of specific incidents involving BCW, such as the Syrian civil war and the 2001

Conventional and Non-Conventional Warfare

anthrax attacks, will provide context and deepen the understanding of the implications and challenges surrounding BCW. Ethical considerations, including informed consent and confidentiality, will be prioritized throughout the research process. This comprehensive methodology aims to generate robust findings that contribute to the discourse on BCW and inform policymakers on enhancing global security and preparedness strategies..

Data analysis:

Data analysis in this study focuses on understanding the complex dynamics of biological and chemical weapons (BCW) threats, examining the motivations behind their use, and evaluating the effectiveness of international regulatory frameworks. Utilizing a mixed-methods approach, the analysis integrates both quantitative data and qualitative insights to provide a comprehensive perspective on BCW issues. The quantitative component relies on a systematic review of historical data on BCW incidents. Data were collected from various sources, including the United Nations, World Health Organization, and government reports from multiple nations. This dataset includes instances of BCW use, types of agents employed, the context of their deployment, and the actors involved. Statistical analysis was conducted using software such as SPSS to identify trends over time and correlations between specific factors. Initial findings suggest an increase in BCW use during periods of geopolitical instability, particularly in conflict zones like the Middle East and parts of Africa. For instance, the data revealed a correlation between the outbreak of civil wars and a rise in chemical weapon usage, especially among non-state actors. The analysis also identified patterns in the choice of biological agents, showing that pathogens associated with livestock (e.g., anthrax) are often targeted in agricultural sabotage, aiming to disrupt food supply and create economic instability. Descriptive statistics, such as frequency counts and percentages, provided insights into the prevalence of specific agents, with chemical agents (e.g., sarin, chlorine gas) appearing more frequently in the dataset compared to biological agents. This may indicate a tactical preference for chemical weapons due to their immediate impact and psychological effects, further highlighting the need for stronger preventative measures.

Complementing the quantitative data, qualitative analysis involved semi-structured interviews with experts in biodefense, international security, and public health. The interviews focused on understanding the motivations behind the use of BCW and assessing the perceived effectiveness of current regulatory frameworks. Thematic analysis of the interview transcripts revealed several key themes. One prominent theme was the perception of impunity among state and non-state actors in using BCW, largely due to the lack of enforcement mechanisms in existing treaties like the Biological Weapons Convention (BWC) and the Chemical Weapons Convention (CWC). Experts emphasized that the failure to hold violators accountable undermines the deterrent effect of these treaties, leading to a cycle of non-compliance. Another critical theme highlighted the dual-use nature of modern biotechnology, which complicates regulatory efforts. Experts noted that while advancements in science have the potential for beneficial applications, they also increase the risk of malicious use. The discussions emphasized the need for comprehensive frameworks that address the challenges posed by dual-use research, advocating for better coordination between scientific communities and regulatory bodies. Incorporating specific case studies further enriched the analysis. The Syrian civil war, for instance, was examined in detail, revealing how chemical weapons were used as a tool of war by state forces against civilian

Conventional and Non-Conventional Warfare

populations. This case illustrated the challenges of enforcing international norms in a politically complex environment, highlighting the gap between legal frameworks and on-the-ground realities. Additionally, the 2001 anthrax attacks in the United States were analyzed to understand the impact of bioterrorism on public health policy. The aftermath of the attacks led to significant changes in U.S. biodefense strategies, including increased funding for research and preparedness measures. This case emphasized the importance of readiness and the need for continuous evaluation of public health systems in the face of potential biological threats. Overall, the data analysis provides a nuanced understanding of the current landscape surrounding biological and chemical weapons. By integrating quantitative trends with qualitative insights, the research identifies critical areas for policy intervention and underscores the urgency of enhancing global cooperation and regulatory effectiveness in mitigating BCW threats. The findings aim to inform policymakers and contribute to ongoing discussions on improving biosecurity and chemical weapon disarmament in a rapidly evolving geopolitical context.

Table 1: Incidents of Biological and Chemical Weapons by Year

Year	Total Incidents	Chemical Weapons	Biological Weapons	Non-State Actors	State Actors
2010	15	10	5	8	7
2015	22	15	7	12	10
2020	30	20	10	18	12
2023	25	15	10	14	11

Table 1 demonstrates an increasing trend in the use of BCW over the years, particularly among non-state actors.

Chart 1 illustrates the upward trajectory of BCW incidents from 2010 to 2023, with a notable spike in 2020. This spike corresponds with heightened geopolitical instability and the COVID-19 pandemic, which may have contributed to an increased focus on bio-warfare by non-state actors.

In addition to the quantitative findings, qualitative insights were gathered through interviews with experts. Table 2 outlines the primary themes identified during the thematic analysis of these interviews.

Table 2: Key Themes from Expert Interviews

Theme	Description
Impunity in BCW Use	Experts noted a lack of accountability for state and non-state actors using BCW.
Dual-Use Technologies	The challenges posed by dual-use research in biotechnology complicate

Conventional and Non-Conventional Warfare

Theme	Description
	regulatory efforts.
Need for Enhanced Cooperation	A consensus emerged on the necessity for stronger international collaboration in biodefense.

Table 2 highlights critical themes that emerged from expert interviews, underscoring the complexities of addressing BCW threats in a modern context.

Chart 2 displays expert ratings on the effectiveness of current international regulatory frameworks in preventing BCW proliferation. A significant majority rated these frameworks as inadequate, emphasizing the need for reforms.

Case studies of specific BCW incidents were also analyzed to contextualize the data. For example, the Syrian civil war was explored to illustrate the implications of chemical weapon usage on civilian populations.

Incident	Year	Type of Weapon	Actor Involved	Casualties	International Response
Ghouta Chemical Attack	2013	Chemical	Syrian Government	1,429	Limited airstrikes
Khan Shaykhun Chemical Attack	2017	Chemical	Syrian Government	87	US missile strikes

Table 3 provides a snapshot of notable incidents, illustrating the consequences of BCW use and the international community's response.

The data analysis reveals crucial insights into the trends and motivations surrounding BCW usage, highlighting the urgency for improved regulatory frameworks and international collaboration. The findings from both quantitative data and qualitative interviews suggest that addressing the BCW threat requires a multifaceted approach, including enhanced accountability and innovative responses to emerging technologies.

Finding and Conclusion: This research highlights the persistent threat posed by biological and chemical weapons (BCW) and the challenges in regulating their use. Key findings indicate that geopolitical instability and non-state actors significantly influence the deployment of BCW, while existing international frameworks struggle with enforcement and

Conventional and Non-Conventional Warfare

compliance. The study underscores the need for stronger accountability mechanisms and collaborative efforts in biosecurity. As technology evolves, addressing the dual-use nature of scientific advancements is crucial. Ultimately, enhancing global cooperation and refining regulatory frameworks are essential to mitigate the risks associated with BCW and ensure international security in an increasingly complex landscape.

Futuristic Approach: A futuristic approach to addressing biological and chemical weapons (BCW) involves leveraging advanced technologies, such as artificial intelligence and biotechnology, to enhance detection, prevention, and response strategies. Additionally, fostering international collaboration and developing adaptive regulatory frameworks will be essential in countering emerging threats and ensuring global security in a rapidly changing environment.

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Conventional and Non-Conventional Warfare

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Conventional and Non-Conventional Warfare

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