Chemical, biological, radiological, and nuclear specialist with 140th Chemical Company, California Army National Guard, dresses in MOPP 4 protective gear at site of notional nuclear attack on Charlestown, South Carolina, April 21, 2021 (U.S. Army Reserve/Darianne Hudson)

Assessing the Trajectory of Biological Research and Development in the Russian Federation

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Throughout the 20th century, biological warfare research and development (R&D) was part of the Kremlin's military posture. Offensive biological weapons research in Russia extends as far back as 1928, and after the Biological Weapons Convention (BWC) of 1972 made such programs illegal, the Soviet Union and then Russia expanded their development. The clandestine Soviet Biopreparat program aimed to weaponize dangerous

pathogens such as *Bacillus anthracis,* the causative agent of anthrax disease, and the smallpox virus, which had been eradicated except in the laboratory setting. At its peak, the Biopreparat program employed tens of thousands of scientists and engineers across hundreds of different facilities.[1] In 1992, Russian President Boris Yeltsin acknowledged the existence of illegal Soviet-era bioweapons programs, but a few years later, in 1999, then–acting President Vladimir Putin denied that these programs had ever existed. Russia has maintained this position ever since.[2] Biosecurity experts raised concerns that these illegal activities never ceased.[3]

In August 2020, the U.S. Department of Commerce added three institutions allegedly associated with offensive biological weapons programs in modern-day Russia to its Entity List of persons and/or organizations found to be engaged in "activities contrary to U.S. national security and/or foreign policy interests."[4] Later that year, the U.S. Government publicly alleged the existence of these programs at the annual conference of the European Union (EU)'s Non-Proliferation and Disarmament Consortium.[5] Around the same time, the Russian Federation put forward a controversial proposal at the United Nations (UN) General Assembly First Committee on Disarmament and International Security. The proposed resolution aimed to make all investigations of alleged chemical or biological weapons use by the UN Secretary General Mechanism (UNSGM) subject to a vote at the UN Security Council.

The United States stated that this proposal was politically motivated and aimed to weaken the UNSGM by placing it in an "overtly political framework designed to end in gridlock."[6] The measure was overwhelmingly rejected by member states. Later, in April 2021, the Department of State issued an official report that concluded, "The United States assesses that the Russian Federation (Russia) maintains an offensive [biological weapons] program and is in violation of its obligation under Articles I and II of the BWC."[7] In March 2022, following the Russian invasion of Ukraine, both the State Department and the White House became even more forthright on Russia's alleged active bioweapons programs, with the White House publicly sharing concerns that Russia may possibly try to "use chemical or biological weapons in Ukraine, or to create a false flag operation using them."[8]

These events are not the only examples of decaying relations around arms control between the United States and Russia. There are also the recent attempted assassinations of the Russian regime's political opponents in 2018 and 2020 through use of the Russian-developed nerve agent Novichok.[9] In December 2020, a journalistic investigation uncovered that Russia's Federal Security Service has a specialized toxins and nerve agent team, which was allegedly involved in the 2020 poisoning of political rival Alexey Navalny.[10] These activities suggest a diminished regard in Russia for international norms, including those with direct relevance to biological and chemical weapons, and indicate a Russian willingness to use unconventional weapons. In March 2021, the United States joined the EU in condemning these actions and imposed targeted sanctions on Russian individuals for the poisoning and imprisonment of Navalny as well as designating scientific institutions as being suspected of being chemical and biological weapons research centers.[11]

In this troubling environment, it is important to understand the range of advanced biological research and current biotechnology investments by the Russian Federation in legitimate areas of biological research and biotechnology development in order to inform an assessment of the sophistication of Russia's alleged biological weapons program. To aid in this landscape analysis, we undertook a two-round Delphi study to elicit expert opinions about the state of Russian research efforts in advanced biotechnologies, including synthetic biology and high-consequence pathogen research, as well as the expected trajectory of biosecurity concerns about such research. The Delphi method of consensus development is a technique to obtain, combine, and analyze collective expert opinion while avoiding groupthink or undue deference to experts. Twelve participants were recruited to take part in this study. All had subject matter expertise and thought leadership in a specific focus area, including the biological sciences, national security, political science, foreign policy and international affairs, economics, and history, as well as experience with Russian biological sciences and knowledge of past weapons programs. After participants answered a series of questions, they were able to see the anonymous answers of their fellow participants. They were then asked to answer the same questions again and were given the opportunity to change their original answers in response to the new information. For this study, participants answered two iterated response-and-feedback rounds. Several experts who participated in this exercise did not wish to be identified as having taken part in it, and so it was decided that all participants would remain anonymous after completion of the study.

The study also included the United States, China, and India in its analyses, in keeping with the aim to reflect on the broader international landscape of advanced biological research. These nations have bolstered support and investments in their biotechnology infrastructure and offer a pertinent point of comparison for better understanding the current and future U.S. and Russian positions as potential leaders in this field and for identifying areas where international scientific engagement could be productive to increase mutual trust and reduce concerns.[12]

Key Findings and Discussion

Concerns About Management, Biosecurity, and Biosafety of Dual-Use Research of Concern in the Russian Federation. Biology and biotechnology R&D in the Russian Federation must be understood within the broader legacy of decades of offensive biological weapons (BW) programs, extending as far back as 1928. The clandestine Soviet program Biopreparat, which grew significantly in the 1970s, specifically focused on harnessing various dangerous pathogens for use in biological warfare.[13] For example, the authors of *The Soviet Biological Weapons Program* estimate that

the State Research Center of Virology and Biotechnology (also known as the VECTOR Institute) might have had the capacity to produce large amounts of weaponized smallpox virus (Variola) and anthrax *(Bacillus anthracis*) in the years before the collapse of the Soviet Union.[14]

Although current Russian President Vladimir Putin has denied the existence of any sort of contemporary offensive biological weapons program, the experts included in this study highlighted that Russian military laboratories have, to this day, yet to be opened to international inspection. In addition, recent Russian activities clearly suggest an increasing, and problematic, desire to weaken international norms, including those with direct relevance to the control of biological and chemical weapons. In 2019, the United States stated that Russia's backing of the Bashar al-Asad regime in Syria enabled the use of chemical weapons against its civilian populations and that Russia had purposefully worked to undermine the attribution investigations led by the Organisation for the Prohibition of Chemical Weapons.[15] The Russian government also allegedly used the chemical nerve agent Novichok in the attempted assassinations of defector Sergei Skripal in 2018 as well as political opponent Navalny in 2020.

Over the years, the Russian government has also worked to erode international norms against the proliferation and use of biological and chemical weapons through dangerous disinformation campaigns. Although these false allegation campaigns can be traced back to Cold War times, the Russian disinformation ecosystem was revived in the 1990s and has continued to grow over the last few years.[16] In 2010, Russia made unsubstantiated claims that the Pentagon was installing a series of biological weapons research laboratories along its borders with the Republic of Georgia. In 2020, Russia, together with Iran and China, propagated conspiracy theories about the origin of SARS-CoV-2, suggesting that the United States had deployed the virus as a biological weapon.[17] More recently, in March 2022, after launching its invasion of Ukraine, Russia initiated a disinformation campaign about nonexistent U.S. biological weapons laboratories in Ukraine.[18] These false allegations about biological weapons use and development not only sow distrust at the global level but also weaken existing biological disarmament norms by indirectly encouraging other countries to breach them.[19]

The experts who took part in this study agreed that recent Russian activities demonstrate a clear and growing willingness to use unconventional weapons. Moreover, study participants noted persistent concerns about biosafety practices and biosecurity awareness to prevent the accidental release, or intentional misuse, of pathogens in Russia. They expressed high levels of concern about the management and oversight of dual-use research of concern (DURC) in the Russian Federation. *DURC* is defined as

life sciences research that . . . can be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, materiel, or national security.[20]

Experts noted that current legal and regulatory frameworks, treaty commitments, or other mechanisms relevant to the development of biotechnology in the Russian Federation were insufficient to limit the potential for dual-use research to be misused. One participant stated:

It should be evident that I have little trust in the Russian Ministry of Defense or the Putin Administration to abide by the relevant international treaty commitments (the BWC). As for Russian internal regulatory mechanisms, insofar as they exist, I would not expect them to offer any impediment to the Russian government if it sought to again violate the BWC any more than the BWC impeded the Soviet offensive BW program between 1972 and 1992.

Additionally, historical evidence, existing Soviet-era bioweapons development infrastructures, and lack of research transparency were most often listed as reasons for concern. One expert noted that "Russian scientists are highly educated and hence the development of anything nefarious is simply a question of political will and funding."

The Delphi study also asked about concerning statements that Putin had made about biological weapons. In 2012, when listing tasks to be accomplished during his administration, he included "the development of weapons based on new physical principles: radiation, geophysical, wave, genetic, psychophysical, etc."[21] The development of genetic weapons would be a clear violation of the BWC, and Putin's mention of it demonstrates, once again, his contempt for international norms. Five years later, Putin spoke of the creation of genetically modified superhuman soldiers that would be "worse than a nuclear bomb."[22] These statements, and counterallegations, may serve to continue weakening the international taboo against the development of biological weapons. Although many experts who participated in this study believe Putin's statements to be propaganda and not based on ongoing research programs, they noted that the statements could still have an impact on the trajectory of biological scientific research in Russia. They agreed that the government would likely direct funds and research in such areas as hybrid warfare: "It's difficult to distinguish between Russian propaganda and actual aims. Putin's comments will certainly embolden some military scientists. Also, Putin often uses scary hyperbole but doesn't understand the complexities and difficulty of making what he calls 'supersoldiers.'"

No participants were aware of Russian research that could embody such statements, but the majority noted that if such research existed, it would be conducted in military institutions and would be classified. Because of the level of complexity and uncertainty involved in this type of research, group members were divided on whether they should be concerned about its potential existence, with one expert stating, "These investments may not necessarily translate into the successful development of such weapons."

Arrival of first batch of Sputnik V vaccines to Argentina, December 24, 2020 (Courtesy Esteban Collazo)

Uncertainty among the experts extended to their concern about Russian efforts around human germline editing, an activity on which scientists from around the world have recommended a global moratorium.[23] In 2019, Russian geneticist Denis Rebrikov, from the Pirogov Russian National Research Medical University, announced his intention to perform germline editing on human embryos using CRISPR (clustered regularly interspaced short palindromic repeats); the research's ultimate aim would be to genetically alter the genes of babies who would otherwise be born deaf, allowing them to hear.[24] Rebrikov's proposal followed the controversial announcement by Chinese scientist He Jiankui of the birth of the world's first babies with edited genomes in 2018.[25] Russian law currently prohibits the use of genetic engineering under most circumstances; most of the experts in this study believed that this research would likely proceed under the radar and "be publicized [only] if successful, to avoid backlash, similar to the one that followed the CRISPR babies experiment" in China. It should be noted that the global scientific consensus is that such experiments ought to be banned until an international ethical and safety framework can be agreed upon, including under what circumstances such research should be allowed to take place.

Current State of Biotech and Biological R&D in the Russian Federation. Most of the experts who took part in the study ranked the current state of biotechnology and biological research in Russia as "advanced" and "somewhat innovative." Experts believed the Russian biotechnology and biological R&D field was "somewhat well-funded" (in contrast to such research areas in China and the United States, which were thought to be "very advanced" and "well-funded") and likely to maintain the current trajectory over the next 5 years, in terms of both developmental pace and funding. Importantly, some experts noted that although Russia may be generally less advanced than China and the United States, it may have highly advanced capabilities in certain areas of interest for health security, such as biopharmaceuticals, vaccine development, and gene editing. Most participants agreed that while Russia is not currently considered a top-tier nation in life-science research compared with the United States and China and still lags in terms of biotech capabilities and related investments, Russia's path is highly dependent on President Putin's efforts to fund and prioritize life sciences going forward. These expert opinions are also supported by prior research evaluating the current state of the life sciences in the Russian Federation.[26]

HMS *Montrose*'s Lynx helicopter dips her nose toward ship during escort duties for Operation *Recsyr*, which calls for expeditious destruction of Syrian chemical weapons program, January 15, 2014 (Courtesy Royal Navy/Alex Knott)

In recent years, Putin has continued to demonstrate some political will to bolster investments and advancements in the Russian biotechnology sector. In 2012, the Russian government launched a new $18 million program called the BIO-2020 strategy, encompassing eight major focus activities, including biopharmaceuticals, biomedicine, and biotechnology. The investment amount, while not substantial, is still notable as the first of its kind in the post-Soviet era.[27] Furthermore, in 2018 Russia's Federal Research Programme for Genetic Technologies Development disclosed its 2019–2027 strategy supporting the development of a comprehensive plan to accelerate the development of genetic technologies.[28] Two years later, in March 2020, Russian Prime Minister Mikhail Mishustin signed an agreement establishing a governmental research center intended to serve as a base for R&D in the fields of genetic technologies and genome editing.[29] It remains unclear how effectively these strategies will be pursued or funded by the Russian government, and whether other investments are being made covertly for classified work and research.

Despite these recent efforts, study participants believed that the economic crisis resulting from the COVID-19 pandemic (the study was conducted before sanctions were instituted after the invasion of Ukraine in February 2022) might limit future Russian investments in biotechnology R&D. Indeed, experts stated that while Russia might continue to invest in life sciences, there was uncertainty as to whether the government would "prioritize accelerating biotechnology investments compared to other more urgent societal needs" stemming from the economic downturn. Now, more than 2 years into the COVID-19 pandemic, the trajectory and status of Russian biological R&D remain to be determined; however, the Russian government chose to prioritize investments in the rapid development of COVID-19 vaccines.

In August 2020, Russia was the first country to approve a COVID-19 vaccine, named Sputnik V in a clear nod to the Cold War–era space race between the United States and the Soviet Union. Russian regulators approved the vaccine before clinical trials were even completed, overriding international norms and sparking concerns. In response, in September 2020, scientists from around the world signed an open letter outlining potentially suspicious patterns in Sputnik V's preliminary trial data as well as inconsistencies in the description of the trial procedures.[30] Even though initial lack of transparency was an issue, Phase 3 clinical data were published in *The Lancet* in February 2021 and showed the vaccine to be safe and effective. These findings were later called into question by an international group of statisticians who outlined "data discrepancies," "substandard reporting," "apparent errors," and "numerical inconsistencies" in the vaccine efficacy data.[31]

Despite these ongoing concerns, as of March 2021, Russia had three approved vaccines against SARS-CoV-2.[32] Multiple countries, such as India, Mexico, and Saudi Arabia, signed up to buy Sputnik V, and 57 countries have approved it for use. In January 2021, Russia applied for vaccine approval in the EU, while several EU countries, such as Hungary and Slovakia, had already individually approved its use.[33] Sputnik V suffered a few setbacks in April 2021, as the Brazilian health agency declined to approve its import due to safety concerns vis-à-vis allegations that its viral vector might be replication competent. Around the same time, Slovakia's drug regulator announced that the batch of Russian vaccines it received did "not have the same characteristics and properties" as the ones used in *The Lancet* studies.[34]

As the West dabbled in vaccine nationalism, Russia initially promised to boost vaccine manufacturing to aid global supply, aiming to score geopolitical points through vaccine diplomacy while bolstering its image as a scientific power. As of January 2022, it had become clear that Russia had fallen short of meeting its supply commitments and international promises, while its domestic rollout lagged far behind those of most European nations and the United States.[35]

Observations and Recommendations

Throughout modern history, national security concerns have often motivated bilateral engagement, including in the science and technology sectors. After the fall of the Soviet Union, science diplomacy mostly aimed to demilitarize the Soviet science infrastructure and engage with Soviet scientists in constructive and peaceful ways.[36] However, science diplomacy between Russia and the United States also dates to the fraught early days of the Cold War, when the United States and the Soviet Union signed the Lacy-Zarubin agreement on "exchanges in the cultural, technical, and educational fields."[37]

Over the years, Russian-U.S. scientific collaboration was often able to transcend political posturing and tense relationships in ways that significantly advanced biomedical research and public health across the world.[38] In 1956, the State Department and the Soviet Ministry of Foreign Affairs fostered collaboration between American virologist Albert Sabin and two Soviet virologists, Mikhail Chumakov and Anatoli Smorodintsev. Sabin first developed the oral polio vaccines, but Chumakov scaled up its production, allowing for the mass production of the vaccine and for large-scale clinical trials. The Sabin oral vaccine has since been used across the globe to significantly stop transmission of the polio virus.[39] In 1958, another Soviet virologist, Viktor Zhdanov, first put forward the idea of smallpox eradication to the World Health Organization (WHO). It was also a Soviet scientist who first developed the technology to freeze-dry smallpox vaccines, allowing them to be transported without cold-chain requirements. This advance enabled American public health expert Donald A. Henderson to steer a highly successful WHO campaign to eradicate smallpox globally.[40]

Despite past successes, science diplomacy between the two nations has never been without challenges. In the mid-1980s, the Soviets engaged in a widespread disinformation campaign alleging that HIV was a biological weapon created by the U.S. military. In 1986, two high-level

Soldier assigned to 56th Chemical Reconnaissance Detachment clears laboratory suspected of housing components for chemical weapons during training exercise in Utah, January 31, 2022 (U.S. Army/Brandon White)

Russian authorities detain opposition leader Alexey Navalny on Tverskaya Street in Moscow, March 26, 2017 (Courtesy Evgeny Feldman)

delegations of U.S. health officials traveled to the Soviet Union to discuss the resumption of official joint committee meetings to expand government health exchanges. At the first such meeting, in 1987, the United States warned it would end all AIDS research collaboration with the Soviets unless the disinformation campaign stopped.[41] Today, Russia continues to use false allegations about biological weapons development to sow distrust and weaken biological disarmament norms, as has become ever more apparent in its recent charges levied about Ukrainian laboratories.[42] In a context of increased insecurity in Europe, the White House and the Global Engagement Center at the State Department must continue to work closely with international allies to actively expose, and publicly counter, Russia's dangerous disinformation tools and techniques.

As sweeping international sanctions take effect following Russia's unprovoked invasion of Ukraine, Western countries have promptly severed many ties with Russia, including broad-ranging scientific engagements and global initiatives. Risking fines and even jail time, close to 8,000 Russian scientists and academics have signed on to a public letter unequivocally denouncing their government's senseless war in Ukraine and sharing their concerns about its ramifications on the future of scientific research in Russia: "The isolation of Russia from the world means further cultural and technological degradation of our country in the complete absence of positive prospects. War with Ukraine is a step to nowhere."[43]

Historically, science diplomacy has been a useful tool to keep communication lines open when security relations are fraught and has led to positive outcomes for both science and national security. However, Russia's invasion of the sovereign Ukrainian nation makes any bilateral engagements between the United States and Russia unconscionable at this time. These actions are unlikely to be forgotten or forgiven swiftly, and sanctions are likely to

persist for some time. Eventually, at an undetermined point in the future, such engagements will certainly again prove to be important for national security and scientific advancement. In March 2022, the presidents of the U.S. National Academies of Sciences, Engineering, and Medicine published a joint letter expressing their solidarity with Ukraine and Ukrainian scientists, also noting that the U.S. National Academies have "a long history of maintaining open lines of communication with the international community, even in dire geopolitical situations" and that they remained "committed to keeping such channels of communication open, including with Russian scientists, many of whom have spoken against the invasion."[44] In these troubling times, track 2 dialogues, including existing collaborative efforts between the U.S. Academies of Sciences and Russian scientists, could eventually be viable avenues in which to engage on critical areas of interest, such as persistent concerns about biosecurity and biosafety, the development of genetic technologies and gene-editing research, and such programs as the Joint Protocol of the U.S. National Academies and the Russian Academy of Sciences on Cooperation in Various Fields of Studies Concerning COVID-19.[45]

As noted in *The Unique U.S.-Russian Relationship in Biological Science and Biotechnology*, a 2013 National Academies of Science, Engineering, and Medicine report, joint bio-engagement programs have enabled scientists to develop long-term professional and personal relationships that have supported scientific innovation and promoted transparency, openness, and confidence-building between nations.[46] Furthermore, Russian scientists often lack experience dealing with Western publishers. It has been documented that past cooperation between American and Russian scientists has often boosted Russian publications in English-language journals and U.S. access to otherwise inaccessible Russian research.[47] While this is significant from a scientific standpoint, the authors of *Biosecurity in Putin's Russia* argue that heavier reliance on open and legitimate Russian publications and research may indirectly enable the U.S. Government to engage Putin on issues related to noncompliance to the BWC without compromising intelligence sources.[48]

In the medium term, such academic engagements may also indirectly address some of the biosecurity and biosafety concerns voiced by the experts in this study, concerns that are bound to worsen in this new era of Russian isolation. Eventually, bio-engagement programs between American and Russian scientists could again be leveraged to emphasize responsible science in the fields of emerging biotechnologies, to promote broader emphasis on bioethics, and to strengthen biosafety and biosecurity by creating and sustaining healthy laboratory cultures, where Russian and U.S. experts can cooperate and share best practices.[49] As noted by the experts who took part in this study, despite its recent interest in bolstering growth and investments in biotechnology R&D, Russia still ranks lower than the United States and China in that regard. The recent unprovoked invasion of Ukraine and subsequent international sanctions are likely to hinder Russia's capacity to grow its biotechnology sector. In the longer term, the specific areas in which Russia lags, such as gene editing and other high-performance genomic technologies, could eventually provide opportunities for engagements between American and Russian scientists when track 2 dialogues usefully resume.[50]

Limitations

The limitations of this study include those that are intrinsic to the Delphi methodology. The anonymized iterative process aims to reduce groupthink, but the conclusions drawn through the process are still shaped by bias at the individual participant level. Indeed, the experts who took part in this research have individual expertise in different fields, including biological sciences, national security, political science, foreign policy and international affairs, economics, and history, as well as experience with Russian biological sciences and knowledge of the past weapons programs, but all were asked to answer the same set of questions, regardless of their specific expertise.

Other potential limitations to this research include the fact that only 12 experts were recruited to participate in the study and that it was not possible to undertake individual follow-ups with each participant to clarify certain statements or responses. These limitations were because of both the demanding iterative nature of the Delphi process and the specialization of the research topic.

Another important limitation to this study involves the inherent secretive nature of scientific research and development in the Russian Federation. The experts in this study were asked for the most part to project their knowledge of legitimate research and related funding trajectories onto possibly covert DURC and/or offensive research in Russia. It is unclear how accurate these projections may be. Many experts acknowledged that most Russian research is not disclosed and that past Soviet infrastructure for offensive work still exists and can be easily leveraged and covertly reengaged. Any offensive research in the Russian Federation would likely be siloed and separately funded from the country's public R&D efforts, and thus projections solely based on the state of legitimate research will always be imperfect. In theory, these caveats should have been somewhat mitigated by the experts' deep knowledge of the history of the Soviet BW program and the current situation in Russia.

Finally, because this study was conducted before Russia's invasion of Ukraine, the expert views outlined in this article do not reflect ways the participants' thinking may have evolved following recent developments. JFQ

Notes

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