

P E R S P E C T I V E

CRISPR Governance at the Nexus of Public Health and National Security: Priority Setting and Risk Calculus in Turkey's Emerging Bioeconomy

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Abstract

CRISPR-based genome editing has moved rapidly from a laboratory technique into a contested object of governance. In public health framings, CRISPR is presented as a platform for treating rare and severe genetic diseases, advancing diagnostics, and reducing long-term burdens on health systems. In national security framings, the same capabilities raise dual-use concerns, including misuse of gene editing and gene synthesis, and motivate research security agendas that manage access to sensitive knowledge, materials, and supply chains. This paper asks two linked questions. Who sets priorities for CRISPR when both public health and national security claims are mobilized, and under what risk calculus are trade-offs justified?

Drawing on science and technology studies, the paper uses co-production and sociotechnical imaginaries to show how definitions of benefit, harm, and acceptable uncertainty are assembled through institutions rather than settled by technical expertise alone (Jasanoff, 2004; Jasanoff & Kim, 2015). Sarewitz's critique that science cannot resolve many risk controversies provides a baseline for analyzing legitimacy (Sarewitz, 2015), while Doudna's reflections after the He Jiankui episode highlight the limits of self-governance and the need for enforceable oversight (Doudna & Kearney, 2020).

Empirically, the paper presents a desk-based case study of Turkey, focusing on two post-pandemic capability-building tracks. First, domestic vaccine development and authorization, exemplified by TURKOVAC,

which became a public symbol of biomedical sovereignty (Ministry of Health of Turkey, 2021). Second, the state-supported genomic infrastructure building through the Türkiye Genome Project, led by TÜSEB, aims to enable precision medicine by expanding national genome and bioinformatics capacity (TÜSEB, n.d.). The analysis reveals that public health and national security often do not function as a clear binary. Instead, priorities are negotiated through boundary work among ministries, regulators, universities, and industry, with uncertainty managed via global guidance documents and narratives of urgency. The paper concludes by proposing bounded openness. It combines inclusive deliberation on value conflicts with targeted biosecurity controls focused on high-consequence misuse pathways, rather than broad restrictions that could undermine public health innovation.

Keywords: co-production, CRISPR, dual use, governance, sociotechnical imaginaries, Turkey.

Introduction

CRISPR has become a general-purpose biotechnology with implications that extend far beyond the laboratory. It is used as a research tool, pursued as a therapeutic platform, and debated as a possible pathway to heritable modification. These features make CRISPR a policy object. It draws actors into struggles over what counts as responsible innovation, who can legitimately decide, and how uncertainty should be managed. The controversy is sharpened by the fact that the same characteristics that support medical promise also enable misuse. Low cost, modular design, and compatibility with adjacent capabilities such as gene synthesis and automation create pathways for dual use (Tucker, 2010).

Public health and national security provide two powerful but often competing lenses for governing CRISPR. Public health logics prioritize disease burden, clinical safety and efficacy, equitable access, and the sustainability of health systems. National security logics prioritize threat prevention, control of sensitive capabilities, strategic autonomy, and resilience of critical supply chains. In the post-COVID period, these logics increasingly overlap under the language of preparedness and health security (Lakoff, 2017), yet they still imply different risk tolerances and different governance instruments. A public health-oriented calculus often weighs expected benefit against expected harm and distributional equity. A security-oriented calculus can treat even low probability risks as unacceptable if consequences are catastrophic.

This paper asks two questions. First, who sets priorities for CRISPR when public health and national security claims are both present? Second, under what risk calculus are trade-offs justified, and whose values become authoritative? The conceptual starting point is Sarewitz's argument that scientific expertise cannot resolve many risk controversies, because risk is political and cultural as much as technical (Sarewitz, 2015). That critique matters for CRISPR because value conflicts over enhancement, intergenerational consent, and inequity persist even when technical performance improves. Doudna's reflections after He Jiankui further show that norms within science are not always sufficient, and that governance must include enforceable frameworks and wider societal engagement (Doudna & Kearney, 2020).

Methodologically, the paper combines a focused literature review with a qualitative desk-based case study of Turkey. The literature review synthesizes STS concepts relevant to priority setting and risk governance, alongside core readings on CRISPR responsibility, technological fixes, and dual use. The Turkey case is chosen because post-pandemic capability building has linked biomedical innovation to national strategy. The analysis centers on Turkey's domestic vaccine development and authorization experience and on the Türkiye Genome Project led by TÜSEB (Ministry of Health of Turkey, 2021; TÜSEB). Together, these initiatives illuminate how health, industrial policy, and security considerations can be braided in a single governance narrative. Self-reflexivity is important because this analysis is conducted from the standpoint of a student researcher relying on publicly available documents and secondary sources. This perspective can overrepresent official narratives and underrepresent informal practices and disagreements within institutions. The paper, therefore, treats policy statements as sociotechnical performances that construct futures and justify priorities, rather than as neutral descriptions. The goal is not to evaluate Turkey's initiatives as successes or failures, but to use them as an STS case for examining how CRISPR-relevant governance is organized at the intersection of public health and national security.

Conceptual and theoretical overview

Co-production and the politics of problem definition

Co-production highlights how scientific knowledge and social order are produced together (Jasanoff, 2004). Instead of treating governance as a downstream reaction to scientific facts, co-production directs attention to how institutions define problems, authorize expertise, and stabilize categories such as benefit, harm, and responsibility. In the CRISPR domain, co-production is visible in how clinical indications are defined, how ethical boundaries are drawn between somatic and germline interventions, and how oversight regimes determine what becomes a legitimate research or clinical pathway. Global governance documents from the World Health Organization and the National Academies do not simply summarize science. They produce standards that travel across settings and reshape local institutional practice (WHO, 2021; National Academies of Sciences, Engineering, and Medicine, 2017). This is especially visible with CRISPR-Cas9, whose rapid diffusion as a programmable editing platform (Cong et al., 2013; Doudna & Charpentier, 2014) helped reframe genome engineering as a broadly accessible infrastructure rather than a niche laboratory technique.

Co-production is especially relevant when value pluralism is irreducible. Sarewitz argues that risk controversies are not solved by more science because different communities interpret uncertainty through cultural commitments and political interests (Sarewitz, 2015). When scientific elites attempt to settle these questions on behalf of citizens, they can deepen mistrust and politicize science. This critique implies that CRISPR governance must attend to how publics are included, how accountability is enforced, and how distributive consequences are recognized.

Sociotechnical imaginaries and the governance of futures

Sociotechnical imaginaries refer to collectively held visions of desirable futures that are stabilized through institutions, public narratives, and material infrastructures (Jasanoff & Kim, 2015). Imaginaries matter because they organize priorities in the present. In CRISPR debates, one prominent imaginary centers on the cure. It foregrounds rare disease therapy, cancer treatment, and precision medicine. Another imaginary centers on the threat that foregrounds biosecurity, strategic competition, and worst-case misuse. These imaginaries select which pathways seem urgent, which actors should lead, and which risks justify constraint.

In many national contexts, post-pandemic policy has further blended imaginaries of health and security. Preparedness discourse frames biomedical capability as protection of the nation, allowing public health goals and national security goals to be articulated as mutually reinforcing (Lakoff, 2017). This can mobilize resources quickly, but it can also narrow deliberation by treating contested ethical questions as matters of urgency rather than democratic choice. Empirical research suggests that these controversies are not only elite debates. Public attitudes toward human genetic modification are patterned and politically meaningful (Weisberg et al., 2017), and effective engagement requires more than one-way science communication (Scheufele et al., 2021). Work synthesizing public opinion and legal precedent also highlights how disability perspectives and lived experience complicate any simple therapy-versus-enhancement boundary (Benston, 2022).

Risk society, uncertainty, and the limits of prediction

Research into risk society outlines how contemporary societies are developing in large part due to the growing number of manufactured risks that are complicated, ambiguous and politically disputed (Beck, 1992). CRISPR is an example of manufactured risk because its ramifications could develop over a long time period, interface with social disparity, and reach beyond the limits of control by single institutions. The control issue illustrates the difficulties that arise in governing manufactured risks during the early stages of their development (Collingridge, 1980). In the early stages of the development of manufactured risks, an institution may effectively navigate manufactured risks by steering through their impacts on other institutions.

Later in the trajectory of the development of manufactured risks, they become more embedded into the existing infrastructures of the market and are much more difficult to remove. The information provided above shows that appraisals of manufactured risks should not lead to premature closure of a specific manufactured risk pathway that is determined to be the best choice. Sarewitz suggests that appraisals be conducted using a broader set of options when developing governance structures for manufactured risks. The creation of governance structures should make apparent any differences in value systems held by various societies in evaluating risks (Sarewitz, 2015).

Technological fixes and why CRISPR is sometimes treated as one

Sarewitz and Nelson propose three rules for technological fixes that help explain when research and innovation can yield rapid social progress and when they cannot (Sarewitz & Nelson, 2008). CRISPR may approximate a technological fix in narrow contexts such as certain monogenic diseases, where causal mechanisms are relatively well defined, and outcomes can be measured clinically. However, CRISPR cannot fix social problems such as inequity in access, disability stigma, or geopolitical insecurity. Treating CRISPR as a fix for these problems risks displacing political debate and giving an illusion of moral resolution. This critique aligns with concerns that broad ethics statements and soft-law declarations may be too weak to guide practice without enforceable institutional mechanisms (Brokowski, 2018).

Dual-use governance across the life cycle

Dual-use governance is a distributed system spanning funders, institutions, journals, firms, and regulators. Gene synthesis is a central site for this distributed governance because it converts digital sequence information into physical genetic material. Tucker's analysis of gene synthesis governance emphasizes screening practices, customer verification, and the limits of purely voluntary regimes (Tucker, 2010). Recent guidance from the US Department of Health and Human Services reflects a

move toward baseline expectations for screening synthetic nucleic acid orders, record keeping, and user responsibilities (US Department of Health and Human Services, 2023). Such instruments can reduce misuse risk, but they also shape innovation by affecting costs and access. Comparative policy analysis shows that governance choices diverge across jurisdictions even when actors reference similar scientific facts, as seen in institutional reports on agricultural gene editing across Europe (Meyer & Heimstädt, 2019). Anticipatory bioethics work on CRISPR and gene drive further illustrates how governance is pulled upstream toward speculative but high-consequence futures (Nestor & Wilson, 2020).

Governance standards as boundary objects

International documents serve as a significant form of coordination among various actors and allow for local interpretations. For example, the WHO's 2021 Governance Framework and the Recommendations for Editing the Human Genome represent an agreement between many International experts regarding what constitutes appropriate oversight for editing the Human Genome and encourage the use of a registry; this will assist in global coordination (World Health Organization, 2019). While the National Academies' 2017 report provides clear governance principles as well as guidance on the types of circumstances in which heritable genetic editing could be permitted, it also places strong emphasis on the need for public input (National Academies of Sciences, Engineering, and Medicine, 2018) The Nuffield Council on Bioethics also has ethical standards and highlights the need for social justice in relation to reproductive and inheritance issues (Nuffield Council on Bioethics, 2019). While the documents enable disagreement to be managed more constructively, they do not eliminate differing views about these topics; rather, they establish a common vocabulary and an expectation of how disagreements are to be managed.

Public engagement and legitimation

Research regarding public attitudes indicates that people's support for human genetic modification is not unconditional; it occurs through a variety of contexts that include the purpose of genetic modification, safeguards for its governance, and individuals' trust in the institutions involved in genetic modification (Weisberg et al., 2019). An examination of the CRISPR babies controversy demonstrates how two competing coalitions constructed narratives regarding the event and how their narratives influenced calls for greater scrutiny and accountability of oversight mechanisms (Rojas-Padilla et al., 2025). In the agricultural arena, scholars who have explored the issue of so-called "democratization" of priority-setting to illustrate how claims of democratization do not necessarily lead to inclusive priority-setting. Rather, claims of democratization can exist alongside networks of individuals with varying levels of expertise, access to resources, and control of the agenda (Wit, 2020). Legal regimes are not a downstream implementation layer. They actively construct what counts as permissible innovation by defining categories, liabilities, and enforceable boundaries, thereby shaping the practical meaning of acceptable risk (Sherkow, 2019). Comparative studies show substantial divergence in gene editing governance even within similar political spaces, which highlights how institutional reports and national contexts produce different regulatory interpretations for the same technology (Meyer & Heimstädt, 2019).

Political economy of access: Patents, public health, and human rights

Patent policies impact the ability of certain parties to develop products and services based on intellectual property and, therefore, set the parameters for the goals of patent development and business models. Researchers have pointed to the need for a cohesive approach to the development

and management of patent policies due to the potential of diverse patent ownership to create higher transaction costs, reduce the amount of new inventions, and therefore increase the likelihood for innovation to be directed towards a few profitable indications (Cook-Deegan, 2018). The public health-oriented perspective on the issues of patenting has raised the issue of whether exclusive rights tend to be at odds with equitable access and has presented ways to in order to achieve a more integrated approach to managing IP with the public interest and population health goals aligned (Sherkow, 2017). From the perspective of human rights and the public interest, access to new genome-editing technologies is viewed as an issue related to the governance of those technologies, rather than simply a matter of commerce (Matthews, 2022). In addition, examples of academic research from the Global South have demonstrated that developing clearer patent landscapes is necessary before developing equitable frameworks for deploying these technologies and for building local capacity (Naidoo & Thaldar, 2022). Evidence of the influence of government and philanthropy on the CRISPR innovation system can provide insight into how the government and philanthropic funding streams have influenced both the types of research programs pursued by university researchers, as well as determining which research programs will become established dominant platforms and which will become marginal (Fajardo-Ortiz et al., 2022). The ethical arguments surrounding the use of heritable genome editing technology are primarily rooted in four areas of concern: Intergenerational Consent, Justice and Disability Politics, and The Social Meaning of Enhancement, which are presented in a way that suggests that all of these ethical arguments are either rooted in one of the four areas of ethical concern or overlap with two or more of the ethical concerns/arguments (Almeida and Ranisch, 2022).

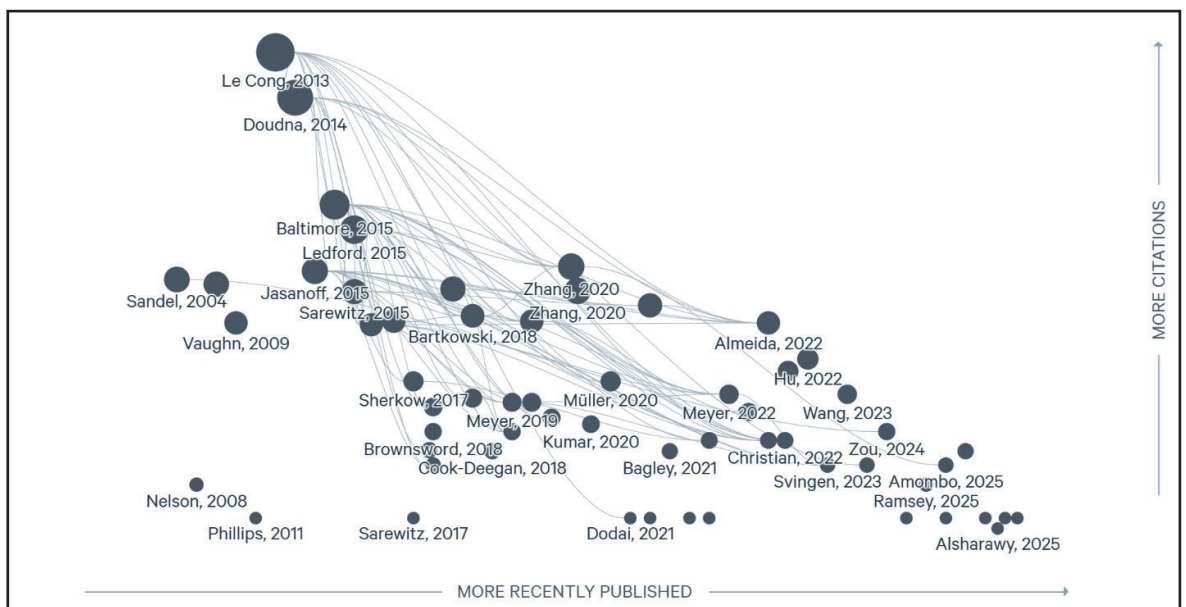


Figure 1: Mapping of CRISPR Governance-related papers and their connections between them produced by Litmaps.

Conceptual framework used in this paper

Building from the literature above, the paper uses a three-part conceptual framework. First, priority setting arenas, meaning the institutional sites where agendas are set, including ministries, regulators, research councils, universities, and industry. Second, risk calculus components, meaning how

trade-offs are justified through claims about expected benefit, uncertainty, and distribution. Third, governance instruments, meaning the tools used to implement choices, including clinical regulation, ethics review, registries, synthesis screening, data governance, and research security policies. This framework treats the public health versus national security axis as a practical tension that appears differently across arenas. It also allows the analysis to connect Turkey's post pandemic capability building to broader STS debates about governance, legitimacy, and the limits of technological fixes.

Historical background of the case in Turkey

Turkey's recent biomedical policy environment has been shaped by COVID-19, which elevated preparedness, supply chain resilience, and domestic production capacity as national priorities. In this context, domestic vaccine development became a visible site where public health and national strategy converged. TURKOVAC received emergency use authorization in late 2021 and was publicly framed as an achievement of local capacity and sovereignty (Ministry of Health of Turkey, 2021). The pandemic also intensified attention to genomics and data infrastructures, both for surveillance and for future precision medicine agendas.

Parallel to vaccine efforts, Turkey has invested in building genomic infrastructure. The Türkiye Genome Project, led by the Presidency of the Institutes of Health of Turkey (TÜSEB), presents itself as a national genome and bioinformatics initiative aimed at analyzing molecular mechanisms of disease, developing new diagnostics and therapies, and enabling individualized medicine. Such initiatives expand sequencing capacity, bio-banking, and bioinformatics, and they can indirectly enable downstream genome editing research by strengthening the broader ecosystem in which CRISPR applications develop. Together, these post-pandemic trajectories provide a setting to examine how health benefits, industrial development, and security concerns become articulated within a single governance narrative.

In addition to being capacity-building initiatives, these actions can also be viewed as narratives that institutionalise how biotechnology is justified in public opinion within Turkey. Through an STS lens, the communication that occurred in relation to domestic vaccine production and genomics infrastructure after the spread of COVID-19 associated the development of biomedicine with national sovereignty, resilience, and strategic value. The manner in which future governance of biotechnologies will be reported upon is not only described in those materials but also contributed to defining the terms used in the articulation of future biotechnology governance.

Discussion of the relevant case

This section applies the conceptual framework to Turkey's emerging bio-economy by analyzing how priorities and risk calculations are assembled across institutions. The goal is not to claim that Turkey is currently a leading CRISPR deployment site. Rather, the case shows how a country can construct enabling infrastructures and governance narratives that will shape future CRISPR pathways.

Priority setting arenas and boundary work

In Turkey, public health institutions, innovation agencies, and research infrastructures occupy distinct but overlapping arenas of priority setting. Post-pandemic vaccine politics created an environment in which domestic capability could be framed as both health protection and strategic autonomy (Ministry of Health of Turkey, 2021). This framing performs boundary work by translating different objectives into a shared language of national benefit.

In Turkey, official institutional documents and capability building announcements serve more than just as a vehicle for communicating policy priorities; they also frame how biotechnology governance is viewed as legitimate based on biomedical investment as connected to sovereignty, preparedness, and national advantage. Viewing these materials through an STS lens allows us to situate it as an authorizing, stabilizing tool for preferred futures for actors and as a definition of what risks can be seen as governable. Yet official narratives should not be read as providing an accurate picture of institutional reality and may underestimate tensions that exist regarding accountability issues, inter-agency discretion, and practical limits of oversight.

Boundary work may also obfuscate distributional issues. In Turkey, these distributional issues are likely to fit into a legal and policy environment defining how advanced therapies will reach clinical use. Even if CRISPR-based interventions are currently not a routine therapeutic reality in Türkiye, access in the future will depend not only on scientific feasibility but also on licensing arrangements, patent concentration, technology-transfer pathways, reimbursement criteria, and the procurement priorities of public institutions. Thus, global tensions regarding intellectual property will become locally visible through how access will be administratively and legally organized. Therefore, as an emerging bioeconomy, patent governance cannot be treated as separate from public health governance. A further analytical caution concerns the relationship between formal discourse and institutional practice. Publicly available documents tend to present coherent narratives of sovereignty, resilience, and public benefit. Yet implementation may involve informal negotiation, uneven coordination, discretionary interpretation, and practical constraints that remain invisible in official texts. In this sense, the sovereignty narrative is better understood as a legitimating frame through which priorities are publicly stabilized, rather than as a complete account of how governance operates in practice.

Risk calculus under dual framings

The public health framing evaluates risk through clinical safety, efficacy, and equity. The national security framing evaluates risk through threat pathways and vulnerability created by dependence on foreign inputs. Under this logic, even low probability misuse may justify controls if consequences are catastrophic.

One additional implication concerns institutional learning. Post-pandemic vaccine development required rapid coordination across regulators, research centers, and manufacturers. Those coordination practices can become templates for future high-stakes biotech decisions, including potential CRISPR therapies and related data infrastructures. From an STS standpoint, this matters because procedural habits formed under crisis conditions often persist. They shape what counts as acceptable evidence, how quickly decisions are expected, and which actors gain agenda-setting power. Building durable governance, therefore, requires moving from ad hoc crisis coordination toward routine, transparent procedures that can withstand contestation and still maintain public trust.

Turkey has demonstrated how the two types of risk calculations can cross over. With respect to vaccines, producing them locally reduces the reliance on worldwide supply chains and meets both health and national security needs. For genomics, developing a national infrastructure for data provides the capability to facilitate the use of precision medicine and provides support for disease surveillance and preparedness. Similarly, when using the CRISPR method of genome modification, crossover may happen again. Investment into research activities within this field, as well as investments in biobanks and bioinformatics, may be justified as a means of producing health innovations, while also raising questions related to how genetic data will be governed, privacy concerns and how biological data will be secured.

Here, Sarewitz's critique is central. If risk is treated as a technical matter to be solved by more science, governance may privilege expert authority and narrow legitimate debate (Sarewitz, 2015). Yet CRISPR controversies often hinge on value conflicts. The boundary between therapy and enhancement is a prime example, and global reports repeatedly stress public engagement as a governance requirement (National Academies of Sciences, Engineering, and Medicine, 2017; WHO, 2021). Doudna's reflections show how violations of perceived ethical boundaries trigger demands for enforceable oversight, registries, and institutional accountability (Doudna & Kearney, 2020).

The Turkish case demonstrates the STS claim that governance helps constitute what a technology becomes by shaping infrastructures, defining priorities, and narrating futures (Jasanoff, 2004). TURKOVAC illustrates how biomedical capability can be framed as national achievement and readiness. The Türkiye Genome Project illustrates how data and research infrastructures are positioned as foundations for future medicine (Ministry of Health of Turkey, 2021; TÜSEB, n.d.). Together, they show how public health and national security logics can be mutually reinforcing while still carrying different implications for openness, accountability, and equity.

Conclusion

CRISPR governance is not only a question of technical safety. It is a question of legitimacy. It asks who is authorised to decide which futures are worth building, which uncertainties are acceptable, and which risks must be rendered intolerable. The public health versus national security axis helps clarify why CRISPR remains persistently contested. It sits at the intersection of care and control, openness and restriction, therapeutic hope and dual-use concern. What is at stake is not merely the management of a technology, but the stabilisation of a particular order of reasons, responsibilities, and publics around that technology.

From an STS perspective, this paper has treated those orders as produced rather than given. Co-production highlights how governance and knowledge-making are mutually constitutive. What counts as a "risk," what counts as "benefit," and even what counts as "responsible innovation" are assembled through institutions, evaluation routines, and the narratives that render some interventions thinkable and others unthinkable (Jasanoff, 2004). Sociotechnical imaginaries provide a vocabulary for that narrative work. They help us see how collective visions of progress, security, and national dignity become material. They travel through policy documents, funding priorities, institutional mandates, and infrastructures, and in doing so they organise both expertise and public expectations (Jasanoff & Kim, 2015). Sarewitz's critique is useful here because it clarifies a recurring political vulnerability. Expert-led risk framing can lose legitimacy when it narrows the space in which values are negotiated and treats contestable judgments as technical facts (Sarewitz, 2015). Doudna's reflections reinforce this point from within the scientific community. They show why self-regulation can be ethically motivating yet practically insufficient when incentives, competition, and uneven accountability shape how boundaries are drawn and enforced (Doudna & Kearney, 2020).

The Turkey case makes these dynamics concrete. Post-pandemic biomedical capability building has not simply expanded laboratory capacity. It has also enabled a sovereignty-oriented imaginary in which biomedical innovation becomes a marker of strategic autonomy. Vaccine development and the national genome initiative can be read in this register. They braid public health commitments to care with national security narratives of resilience and self-reliance (Ministry of Health of Turkey, 2021; TÜSEB, n.d.). In this setting, bounded openness is best understood as a situated governance

style rather than a compromise between two fixed poles. It is an attempt to keep collaboration and therapeutic development open enough to sustain learning and translation, while tightening controls at points where misuse pathways are high-consequence and where upstream leverage is real, including synthesis screening (US Department of Health and Human Services, 2023).

Once the issue is framed in these terms, the policy problem looks less like a knowledge deficit and more like a coordination problem across domains built to pursue different goods under different logics. Oversight for CRISPR is distributed across public health, security, and innovation institutions. That distribution can make decision criteria drift across the research-to-application life cycle. The drift becomes visible in three recurring gaps. First, triggers remain unclear. Examples of illustrative decision triggers could include (but are not limited to) any edits made to pathogens of extreme concern; combining genome editing with exceedingly sensitive capabilities for synthesis or delivery or scale up; requests for access to either materials or protocols with known dual-use implications; or cross-border sharing of knowledge about a technology where the potential consequences of misuse are exceedingly high. These triggers do not imply that such cases must automatically be prohibited, but instead warrant higher levels of scrutiny, more meaningful reporting requirements, and collaboration among the health, research, and security sectors. The advanced publication of “triggers” can help reduce arbitrary decisions, and/or enable researchers who are legitimately engaged within these fields to plan accordingly, with greater certainty as to when heightened scrutiny may commence.

It is often uncertain when national security scrutiny should attach to projects that are otherwise legitimate health and innovation work. Second, legitimacy-making is thin. Transparency and structured public engagement tend to be limited precisely where moral and distributional stakes are highest. Third, interoperability is weak. As access to collaboration, funding, and clinical translation increasingly depends on alignment with international baselines, weak coupling to global reporting and standards becomes a governance risk in its own right. International guidance emphasises proportionality, accountability, and shared minimum rules for oversight. That contrast helps make the Turkish case legible as a governance configuration rather than an isolated tension (National Academies of Sciences, Engineering, and Medicine, 2017; World Health Organization, 2021).

This framing also reshapes how policy orientations appear. A security-first restriction posture can reduce exposure to catastrophic misuse, but it risks over-breadth and can incentivise opacity in legitimate research, especially when controls are experienced as unpredictable or insulated from scientific and clinical realities (National Research Council, 2004; Sarewitz, 2015). A health and innovation-first openness posture can accelerate therapeutic development and align with bioeconomy ambitions, yet it can under-address upstream leverage points and underestimate dual-use pathways that do not wait for clinical translation (Doudna & Kearney, 2020; World Health Organization, 2021). For this reason, a risk-tiered, adaptive approach is better understood not as a technocratic “middle option,” but as an institutional strategy to keep plural goods in view. It scales oversight with intended use and plausible misuse, while revising thresholds as capabilities and threat models change. This is also the orientation most consistently echoed in international recommendations, including higher evidentiary and procedural thresholds for heritable or otherwise high-stakes applications (National Academies of Sciences, Engineering, and Medicine, 2017; World Health Organization, 2021; National Academy of Medicine, National Academy of Sciences, and the Royal Society, 2020).

For Turkey’s emerging bioeconomy, the operational implication is to treat bounded openness as something that must be built, maintained, and audited, rather than assumed. For operational

purposes, this would mean that we would want to keep as many low-risk biomedical collaborations, clinical data learning, and international registry participation as possible while concentrating on some small number of high-leverage control points (e.g., synthetic nucleic acid screening, institutional dual-use review, mandatory biosafety and research-related security training for relevant laboratories, documenting sensitive procurement, and establishing formal escalation pathways for projects that exceed acceptable risk levels). As a result, Türkiye will be able to help build capacity in biomedical areas, rather than throwing everything genome-related into a generic security policy framework. The process would begin with the establishment of a venue for health, security, and innovation authorities to define common risk classifications and to publish clear decision-making criteria. Also, the concept of “moving up” the security issue in terms of developing standards will take place. The formal protections (e.g., screenings and record-keeping) surrounding synthetic nucleic acids, similar to those already established within the realm of established biomedical research (U.S. Department of Health and Human Services, 2023), should target “high-leverage” points while remaining compatible with day-to-day biomedical research activity. The capacity of an institution will be critical in achieving success. The dual-use evaluation and training systems provide the channels via which abstract responsibilities are transformed into enforced mandates; there are many strong lessons in the biosecurity literature that demonstrate how such procedures promote prevention and accountability (National Research Council, 2004). Additionally, legitimacy cannot be created retroactively after an issue develops into controversy, although legitimacy in a centralized structure needs to ensure that inclusive deliberation does not occur merely as a symbolic process once determination of priorities has occurred. For legitimacy to be credible, inclusive deliberation must occur early enough in the development of a governance framework to allow for the establishment of the working agenda, defining thresholds, and determining how benefits and risks shall be assessed. Practically, this could involve consultation with structured procedures that allow for input from patient advocacy groups, practitioners, bioethicists, legal scholars, biosafety practitioners, and representatives from civil society; and making documentation available that demonstrates how their comments have influenced the criteria used for making decisions or selecting processes. Without such a feedback loop, the exercise of providing input could be perceived as more of a performance than an essential component to building legitimacy.

Deliberative public engagement is most meaningful when it occurs early enough to shape how problems are defined and what trade-offs are treated as acceptable. Empirical work on CRISPR-related engagement indicates that the design and process quality of participation strongly affects whether it produces learning and trust or simply rehearses conflict (Scheufele et al., 2021). Aligning clinical translation pathways with global standards, including registry participation and cross-border reporting, further supports collaboration and reduces uncertainty for researchers and clinicians (World Health Organization, 2021; National Academy of Medicine, National Academy of Sciences, and the Royal Society, 2020). Finally, if governance is to claim legitimacy in a public health register, access and affordability should be treated as governance requirements rather than downstream afterthoughts. Funding conditions, procurement levers, and attention to patent policy dynamics are relevant tools for reducing exclusion in who can benefit from innovation (Cook-Deegan, 2018).

What ultimately makes such a framework credible is not only its architecture but its capacity to learn. Monitoring indicators such as time to ethics and biosafety approval, compliance with screening and training, the regular publication of public reports, and participation in international registries can function as signals of whether bounded openness is operating as intended or merely as rhetoric.

Revising requirements on a fixed cycle, for example every two years, can keep oversight responsive as technical capabilities and geopolitical pressures evolve, and can help prevent governance from hardening into either reflexive restriction or performative openness (World Health Organization, 2021).

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Ethics committee approval

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Author's contribution statement

Study conception and design: ZD; Data collection: ZD; Analysis and interpretation of results: ZD; Manuscript draft preparation: ZD. The author reviewed and approved the final version of the manuscript.

Use of Artificial Intelligence: During the preparation of this work, I used ChatGPT5.2 Pro and Scispace in order to conceptualize. After using this tool/service, I reviewed and edited the content as needed and take full responsibility for the content.

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