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Bioinformational Diplomacy and Mobile Health Apps: Response to Global Health Crises and International Cooperation

Biyobilgi Diplomasisi ve Mobil Sağlık Uygulamaları: Küresel Sağlık Krizlerine Yanıt ve Uluslararası İş Birliği

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ABSTRACT

This study analyses the role of biological information diplomacy in international health crises within the context of the COVID-19 pandemic, focusing on how political, technological, and diplomatic processes contribute to global health security. The international sharing of genetic sequencing data has accelerated vaccine and treatment development processes, enabling collective and rapid responses to global health threats. Based on a qualitative document analysis, the study utilises data gathered from official websites, academic literature, and international reports to draw its conclusions. During the global pandemic, mobile applications have played a significant role in supporting public health and facilitating data sharing. With features such as symptom tracking, exposure notifications, and risk zone identification, these applications have enhanced access to healthcare services. However, concerns about data privacy and security have emerged as fundamental issues that limit biological data sharing processes. Biological information diplomacy has proven to be a critical tool for enhancing international cooperation during health crises. While mobile technologies support its implementation, the development of data-sharing standards, reduction of inequalities, and enhancement of public trust are essential for achieving sustainable biodata diplomacy. The study underscores the contribution of equitable and fair information sharing to global health security in future crises. Drawing on innovative technological approaches,

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biological information diplomacy and mobile applications are expected to continue serving as effective tools at both the individual and societal levels. The data were analysed using MAXQDA 2024 software through thematic content analysis and were classified under three main themes: “objectives and functions,” “data-sharing methods,” and “public relations roles.” The findings reveal that mobile health applications not only influence individual health behaviours but also play strategic roles in digital diplomacy, biodata diplomacy, crisis communication, and international public relations strategies. Transparent structures based on voluntary and anonymous data sharing have facilitated collaboration in health data, while in-app communication mechanisms have increased public trust during crises and contributed to the construction of a positive public image of the government. The results indicate that these technologies hold strategic value for both healthcare delivery and sustainable diplomacy in future global health emergencies.

Keywords: Bioinformational diplomacy, Covid-19, data security, health communication

ÖZ

Çalışma, biyobilgi diplomasisinin uluslararası sağlık krizlerindeki rolünü COVID-19 salgını bağlamında ele alarak politik, teknolojik ve diplomatik süreçlerin küresel sağlık güvenliğine katkılarını analiz etmektedir. Genetik dizilim verilerinin uluslararası paylaşımı, aşı ve tedavi geliştirme süreçlerini hızlandırmış, küresel sağlık tehditlerine kolektif bir yanıt verilmesine olanak tanımıştır. Çalışma nitel doküman analizine dayandırılmış olup resmî web siteleri, akademik literatür ve uluslararası raporlar gibi kaynaklardan elde edilen verilerden elde edilen sonuçları kapsamaktadır. Küresel salgın döneminde mobil uygulamalar, halk sağlığını destekleme ve veri paylaşımını kolaylaştırma bağlamında önemli rol oynamıştır. Semptom takibi, temaslı birey bildirimleri ve riskli bölgelerin tespiti gibi işlevlerle halk sağlığını destekleyen bu uygulamalar sağlık hizmetlerine erişimi kolaylaştırmıştır. Ancak veri gizliliği ve güvenliği konusundaki endişeler biyobilgi paylaşımı süreçlerini kısıtlayan temel bir sorun olarak belirlenmiştir. Biyobilgi diplomasisi, sağlık krizlerinde uluslararası iş birliğini güçlendiren kritik bir araçtır. Mobil teknolojiler, biyobilgi diplomasisinin uygulanmasını desteklerken veri paylaşımı standartlarının güçlendirilmesi, eşitsizliklerin azaltılması ve toplumsal güvenin artırılması, sürdürülebilir bir biyobilgi diplomasisi için hayati önemdedir. Çalışma, adil ve eşitlikçi bilgi paylaşımının gelecekteki sağlık krizlerinde küresel sağlık güvenliğine katkılarını vurgulamaktadır. Teknolojideki yenilikçi yaklaşımlarından destek alan biyobilgi diplomasisi ve mobil uygulamalar, gelecekteki sağlık krizlerinde bireysel/toplumsal düzeyde yenilikçi çözümler sunarak sağlık güvenliğini güçlendiren etkili araçlar olmaya devam edecektir. Verilerin analizinde MAXQDA 2024 yazılımı kullanılarak tematik içerik analizi uygulanmış, elde edilen bulgular, “amaç ve işlevler”, “veri paylaşım yöntemleri” ve “halkla ilişkiler rolleri” olmak üzere üç ana tema altında sınıflandırılmıştır. Bulgu-

lar, mobil sağlık uygulamalarının yalnızca bireysel sağlık davranışlarını yönlendirmekle kalmayıp aynı zamanda dijital diplomasi, biyobilgi diplomasisi, kriz iletişimi ve uluslararası halkla ilişkiler stratejilerinde de etkin rol oynadığını ortaya koymaktadır. Gönüllü ve anonim veri paylaşımına dayalı şeffaf yapılar, sağlık verisi iş birliğini kolaylaştırmakta; uygulama içi bilgilendirme mekanizmaları ise kriz dönemlerinde kamu güvenini artırarak hükûmetlerin olumlu kamuoyu imajı oluşturmasına katkı sunmaktadır. Elde edilen sonuçlar, bu teknolojilerin gelecekteki sağlık krizlerinde hem hizmet sunumu hem de sürdürülebilir diplomasi açısından stratejik bir değer taşıdığını göstermektedir.

Anahtar Kelimeler: Biyobilgi diplomasi, Covid-19, veri güvenliği, sağlık iletişimi

Introduction

Shaped by innovative approaches to technology, biomedical information diplomacy is becoming increasingly important as a diplomatic framework to regulate the international sharing of biomedical data in support of global health security. The concept plays a critical role in facilitating the sharing of biomedical information necessary for the rapid diagnosis and control of diseases, especially during global health crises such as COVID-19. The contribution of technology in these processes facilitates and accelerates bioinformational diplomacy. The main purpose of bioinformational diplomacy is to ensure the flow of information between countries during periods when health threats have gained a global dimension, to ensure the quarantine of diseases whose spread is accelerating and to increase global health security. This process is parallel to scientific and technological dynamics and is shaped in harmony with multifaceted structures that include political, commercial, economic, and ethical dynamics. While health diplomacy facilitates disease prevention through the sharing of bioinformation, it also assumes important functions in building trust and managing crises in international relations. Türkiye's work in this field represents a significant starting point and has the potential to enhance the country's role in international health diplomacy. Türkiye's steps in the field of bioinformational diplomacy have strengthened the country's domestic health policies and helped the country gain a place on the global health agenda.

Historically, efforts toward international health security have been developed to control the cross-border effects of infectious diseases and institutionalised through regulations such as the International Health Regulations. However, with the recent COVID-19 pandemic, whose devastating effects have reached an international scale, it has once again become clear how critical bioinformational sharing is in responding to global health threats. The sharing of biogenetic data during the early pandemic period demonstrated the effectiveness of bioinformational diplomacy by contributing positively to advances in vaccine and treatment development. The sharing of genetic sequence data has accelerated the vaccine and treatment development processes, demonstrating the importance of international cooperation. However, concepts such

as data privacy, biosecurity and intellectual property create obstacles that cannot be ignored in bioinformational sharing processes. In particular, areas such as the protection of intellectual property rights and the establishment of security protocols are among the key areas that require regulation to ensure the sustainability of bioinformational diplomacy.

The study provides an important framework as it is one of the first academic studies on bioinformational diplomacy in Türkiye. In terms of strengthening Türkiye's position in global health diplomacy and developing more effective solutions to international health crises, the presentation of data has the potential to be the subject of new research. Türkiye's pioneering work in this field makes the country's role in bioinformational diplomacy more visible and strengthens its ability to influence health policies around the world. In this study, the conceptual foundations of bioinformational diplomacy, the historical development of and its role in the COVID-19 pandemic are discussed in detail, and the challenges faced in bioinformational sharing and suggestions for overcoming these challenges are discussed. Türkiye's pioneering work in this field offers a unique perspective to enhance the capacity of bioinformational diplomacy to respond to global health crises. However, the existing literature has not systematically examined how bioinformational diplomacy manifests through digital tools—particularly mobile health applications—within the context of international public relations. This gap stems from an inability to clearly demonstrate how these digital platforms facilitate global data sharing, what mechanisms bring together key actors (governments, international organisations, technology firms), and how these processes impact global health governance, public trust, and crisis communication. Therefore, the primary aim of this study is to analyse mobile health applications developed during the COVID-19 pandemic under the framework of bioinformational diplomacy, focusing on their national and international public relations dynamics, to fill theoretical and practical gaps in the field. Additionally, this research is expected to offer original contributions to the health diplomacy literature by systematically evaluating how these applications function in critical dimensions such as data security, user privacy, ethical protocols, and digital inequality.

Bioinformational Diplomacy: Global Cooperation and the New Paradigm of Health Security

Conceptually, studies in the field of diplomacy point to the growing diplomatic importance of non-state actors as well as informal diplomatic practices that are increasingly characterized by multilateralism, which is more open, networked and less state-centric in the 21st century (Willetts, 1997, p. 14; Mazıcı, 2020, p. 102; Erdoğan, 2020, p. 89). These include paradiplomacy studies (Batal & Tuğlu, 2018, p. 45; Erdoğan, 2020, p. 91), interprofessional diplomacy (Constantinou et al., 2016, p.29), everyday diplomacy,

science diplomacy (Sütçü, 2012, p. 78; Yıldırım & Bulut, 2021, p. 210), global health diplomacy (Katz, 2009, p. 125; Battır, 2019, p. 24), private diplomacy (Türker et al., 2021, p. 210), grassroots diplomacy (Payne, 2009, p. 63) and data diplomacy (Baştan & Karagül, 2021, p. 789). These studies reveal that the understanding of diplomacy is becoming more complex and multidimensional with each passing day, and that actors other than states play active roles in the process.

Bioinformational diplomacy is defined as a field that encompasses the sharing, management, and protection of biological data and information within the framework of international cooperation (Glowka, 1994, p. 9), covering a wide range, from genetic data to biodiversity information. Bioinformational diplomacy, which was first framed by international agreements for the protection of biodiversity, has gained importance in issues such as global health crises, food security and climate change. In particular, the COVID-19 pandemic, the most recent global pandemic, has revealed the importance of bioinformational diplomacy in finding solutions to global problems.

The foundations of bioinformational diplomacy date back to the international negotiations on environmental and biodiversity issues that began in the 1970s. Signed in 1992, the Convention on Biological Diversity (CBD) established the basic contours of bioinformational diplomacy by envisioning a fair and balanced sharing of biological resources. It emphasised the principle of national sovereignty and encouraged international cooperation. Glowka (1994, p. 14) states that the CBD was a turning point in international biological resource management, providing a legal framework for the sharing of biological data. Towards the end of the 20th century, the start of genome projects brought a new dimension to bioinformational diplomacy. In 2003, with the completion of the Human Genome Project, a dynamic transformation occurred in the international sharing and cooperation of genetic data. The Human Genome Organisation (HUGO), for example, has led the way in establishing basic principles for the open and transparent sharing of biological data. The international collaborative collection and analysis of genetic data has also supported the development of scientific and diplomatic relations. According to Tollefsen (2017, p. 67), the sharing of genetic data has increased trust between countries along with scientific progress. Outbreaks such as SARS and H1N1 in the 2000s crystallised the importance of bioinformational diplomacy in the field of health. During this period, the World Health Organisation (WHO) adopted policies encouraging the sharing of genomic data. The COVID-19 pandemic, which emerged in 2019, once again highlighted the critical role of bioinformational diplomacy in international crises. In this process, platforms such as GISAID enabled the rapid sharing of SARS-CoV-2 genomic data. At this stage, questions such as data security emerged, and research has shown that GISAID protects the rights of data owners while ensuring the safe and rapid sharing of genomic data (Karmakar et al., 2021, p. 145). The Nagoya Protocol provides a framework for access to genetic resources and the benefits derived from these resources. The main purpose of the Protocol is to

protect the original sources of the source countries by ensuring fair sharing of biological data (CBD, 2010). The Nagoya Protocol promotes the sustainable use of biological resources and strengthens bioinformational diplomacy processes (Glowka et al., 2012, p. 35). Strengthening data security standards is critical for the sustainability of bioinformational diplomacy (Helewood et al., 2018, p. 102). The European Union's General Data Protection Regulation (GDPR) stands out as an important regulation to ensure the security of biological data. According to Elbe (2021, p. 662), bioinformational diplomacy encompasses both formal intergovernmental negotiations in diplomatic forums (World Health Organisation, Biodiversity Convention, etc.) and a broader understanding of diplomacy. Thus, like other forms of diplomacy, it involves more flexible and multilevel forms of diplomatic communication in which non-state actors are involved in the processes while playing a role in inter-state negotiations.

On 26 September 2019, Stefan Elbe introduced the concept of bioinformational diplomacy for the first time at the workshop "Managing Global Health Security in the 21st Century" organised by the University of Vienna. In 2021, he published an article in the European Journal of International Relations titled "Bioinformational Diplomacy: Global Health Emergencies, Data Sharing And Sequential Life" in the European Journal of International Relations in 2021. Elbe's (2021, p. 663) academic conclusions on bioinformational diplomacy show that the sharing of biological data plays a critical role in reshaping policies in international relations. This research reveals the profound and constitutive nature of bioinformational diplomacy's connection to the life sciences in the field of international relations. Elbe emphasises that the concept is more than a theoretical concept; it is a tool with the capacity to influence inter-state relations, finding application in concrete areas such as global health security. In addition, the study examines how laboratory practices for sequencing life at the molecular scale also reshape the game of sovereignty and power (Elbe, 2021, p. 664). In this context, bioinformational diplomacy becomes a resource that can influence the power dynamics of states and international organisations. In his study, Elbe (2021, p. 665) calls for an in-depth examination of bioinformational diplomacy and shows how it is becoming increasingly critical to the international power, trade and security game in contemporary world politics, emphasising that we need to rethink international relations in terms of information-sharing relations. The effectiveness of bioinformational diplomacy in inter-state relations is directly related to the management and sharing of information/data, but the process also involves political, economic and ethical dimensions. In addition, scientists are potentially unofficial diplomatic actors who engage in sub-diplomatic practices in continuous forms to provide globally valuable sources of knowledge across international and geopolitical divides (Elbe, 2021, p. 666). Scientists bear great responsibility for knowledge sharing, and potential tensions between states sometimes restrict the free flow of knowledge. The long-standing problem of global scientific competition and inequality during pandemics also intersects with broad-

er international political and economic sensitivities (Aarestrup & Koopmans, 2016, p. 241). Global health crises highlight the importance of bioinformational diplomacy and competition between states. Even when scientists are ready to share information, governments may tend to restrict the international sharing of disease data. (Aarestrup & Koopmans, 2016, p. 243). Therefore, cooperation between governments and scientists becomes an important area for bioinformational diplomacy to function effectively.

Bioinformational diplomacy is emerging as an important diplomatic field that shapes inter-state cooperation, power dynamics, and global health security in a wide range of international relations, except in cases where health crises require quarantine. It also adds a new dimension to international diplomacy by establishing a tight link between information sharing, scientific competition and global health issues. Bioinformational diplomacy has been at the intersection of scientific, political and diplomatic processes throughout its historical development. This concept, which has emerged as an effective tool in addressing various issues, from biodiversity to health crises, today encourages international cooperation and contributes to the solution of global problems. Handicaps such as data privacy, inequality and trust issues continue to limit the effectiveness of bioinformational diplomacy. In the future, strengthening technological innovations and international cooperation will increase the sustainability of bioinformational diplomacy.

Sharing Bioinformational: Opportunities and Challenges

Bioinformational diplomacy is an important area for global health security and international cooperation. The COVID-19 pandemic, which has recently attracted attention as a global problem, has highlighted the critical role of bioinformational sharing in developing rapid and effective responses to global health crises. This diplomatic network, which requires cooperation with various actors at the national/international levels, is evolving in response to the possibilities offered by technology. According to Elbe (2021, p. 662), technology plays a central role in bioinformational diplomacy alongside actors such as governments, scientists and the private sector. For example, mRNA technology and gene sequencing methods used in vaccine development processes, which are of primary importance in times of global pandemics, have made it necessary to share bioinformation rapidly. Global challenges are times when global collaborations must be at the centre of research to create more flexible frameworks. According to Shu and McCauley, the GISAID platform provides an effective example of bioinformational diplomacy by enabling the rapid sharing of SARS-CoV-2 genomes (Shu & McCauley, 2017, p. 208). However, countries with weak biotechnological infrastructure are disadvantaged in these processes (Fleming et al., 2020, p. 1998). In situations that threaten public health and require urgent solutions, the importance of technological infrastructure increases and the need for assistance from underdevel-

oped and/or developing countries to developed countries increases. The adversities experienced in the historical process reveal the impact of technological inequalities on the inclusiveness of bioinformational diplomacy.

The international sharing of bioinformational entails numerous political, security, and commercial challenges. Among these, intellectual property rights are frequently debated, particularly in the context of global health emergencies. As Contreras & Bergman (2019, p. 3) argue, the classification of bioscientific data used in vaccine and drug development as trade secrets can significantly hinder international cooperation during pandemics. The lack of security protocols for data sharing also increases biosecurity risks. Maxmen (2021, p. 1) exemplifies this issue, finding that speculation that SARS-CoV-2 could be used as a bioweapon has created insecurity in biodata sharing processes. These and similar situations jeopardise the effectiveness of collective responses to global health threats. Applications and tools developed within the scope of bioinformational diplomacy facilitate international cooperation. Next-generation sequencing technologies (NGS) have become one of the key technologies enabling the rapid and reliable sharing of bioinformational (WHO, 2021). In addition, cloud-based data sharing platforms enhance collaboration among researchers (Shu & McCauley, 2017, p. 208). However, international standards and data sharing protocols need to be established for the effective use of such technologies (Moon et al., 2017, p. 238). For example, mobile health apps used during the COVID-19 global crisis supported biodata sharing with functions such as contact tracing and symptom reporting. Along with the high level of benefits of these technology-enabled applications, it also reveals the need for more effective use of protocols such as data privacy and security. According to Flemeng et al., concerns about the privacy and security of data[3] collected through these applications have limited public trust in these technologies (Fleming et al., 2020, p. 1999). However, sharing genomic data quickly and reliably is a necessity for the rapid detection, prevention, and control of diseases. In such cases, one of the primary duties of governments is to reassure the public that the necessary precautions are taken by raising awareness of security protocols that will encourage them to share their data voluntarily.

Every threat to the security of the state and its people requires the development of strategies to find solutions. The advantages of these strategies are accompanied by risks and disadvantages. Existing challenges need to be overcome to effectively implement bioinformational diplomacy. In particular, the biotechnological shortcomings of low- and middle-income countries create inequalities in the global sharing of bioinformational, which need to be supported by international cooperation. Such inequalities

[3] Genomic data includes DNA sequences containing all the genetic information of a living organism and details about these sequences. This information includes data on the structure, function and organisation of genes. Genomic data are used in many fields such as the investigation of genetic diseases, the study of the evolutionary processes of species and the understanding of genetic diversity (https://www.eresbiotech.com/blog/biyoinformatik-icin-temel-biyoloji-bilgileri).

can be addressed by strengthening the technological infrastructure and establishing financial support mechanisms. In addition, establishing international standards to ensure data security will support the sustainability of bioinformational diplomacy. The development of ethical standards in data sharing will also contribute positively to the data sharing processes in the countries. The International Health Regulations (IHR) support the flow of bioinformation by requiring member states to share events that threaten public health with the World Health Organisation (WHO, 2005). Fair and equitable sharing of bioinformational is essential to develop a collective response to global health threats (Moon et al., 2017, p. 245). The effectiveness of bioinformational diplomacy depends on strengthening international cooperation and prioritising common interests.

Infectious Diseases and the Strategic Use of Bioinformation

The threats posed by infectious diseases that know no borders have continued to threaten human history for centuries. The World Health Organisation defines epidemics as the spread of infectious diseases affecting a larger number of people than expected in a given community, region, or geographical area (WHO, 2020, p. 5). According to the World Health Organisation, the main characteristic of an epidemic is an abnormally high rate of spread and infectiousness of the disease. The term "epidemic" is derived from the Ancient Greek words "epi" (meaning "on" or "upon") and "demos" (meaning "people"), and refers to the widespread spread of disease in a society (Morens et al., 2009, p. 180). The first examples of epidemics in human history emerged with the beginning of settled life after the agricultural revolution. In particular, the Plague of Athens, which occurred between 430 and 426 BC, is recorded as one of the first major epidemics documented in written history (Thucydides, 1998, p. 42). Early efforts to combat epidemics were largely limited to the national and local levels. For example, during the Black Plague that ravaged Europe in the 14th century, some city-states, such as Venice, implemented the first quarantine practices (Gensini et al., 2004, p. 258). Outbreaks were often attributed to mystical or religious reasons, and methods such as religious ceremonies and "purification" of society were used to combat infectious diseases rather than scientific methods. During the Great London Plague of 1665 in England, the city administration isolated infected individuals in their homes, but the measures were not sufficient, and the spread of the disease increased (Slack, 1989, p. 71). In the modern era, the concept of a pandemic was first used in the 19th century during the outbreak known as the Russian Flu, which occurred between 1889 and 1890 (Honigsbaum, 2020, p. 115). This pandemic showed that diseases could rapidly cross international borders with the development of global trade routes. In the 20th century, outbreaks such as the Spanish Flu of 1918 made the concept of pandemic more prominent in scientific and political literature (Taubenberger & Morens, 2006, p. 15). The World Health Organisation uses pandemic to refer to outbreaks that spread to more than one country or continent and create widespread effects worldwide (WHO,

2020, p. 6). According to Harrison, international efforts to control the spread of the disease date back to the second half of the 19th century (Harrison, 2006, p. 198). The 1851 International Health Conference encouraged the sharing of disease data among countries (Fidler, 2001, p. 59). Such measures taken against cholera outbreaks form the basis of modern international public health policies. The establishment of the World Health Organisation in 1948 was an important milestone in seeking a collective response to international health crises. In 1951, the International Sanitary Regulations were established, and in 1969, these regulations were amended into the International Health Regulations, leading to the emergence of the international health security regime. According to Fidler, these organisations, under the influence of the colonial and expansionist policies of European leaders, aimed to ensure not only health security but also the continuity of trade (Fidler, 2005, pp. 326-327). Organisations and regulations have made it mandatory for states to inform each other of the presence of certain diseases in their territory and to implement standardised measures to control the entry of diseases across their borders. Cooperation has therefore made it mandatory for states to agree on sharing information and implementing preventive measures that do not disrupt international travel and trade (Bjorkdahl and Carslen, 2018, p. 60). In particular, the SARS outbreak in 2002-2003 demonstrated the importance of early warning systems and data sharing against the cross-border spread of diseases (Heymann and Rodier, 2004, p. 173). Similarly, during the H1N1 pandemic in 2009, the World Health Organisation developed global vaccine distribution systems to limit the spread of the disease. However, the inequality between low- and middle-income countries and developed countries in these processes highlighted the need for the development of international health cooperation mechanisms (Fleming et al., 2020, p. 1996). In 2005, the World Health Organisation updated the International Health Regulations (IHR) and redefined the obligation of member states to report transboundary health threats (WHO, 2005, p. 8).

In terms of how we understand and deal with the microbial world today, McInnes states that “disease knows no borders”. Three arguments have been made in McInnes’ conceptualization of the microbial threat:

1. Science and innovation alone are not enough to tackle emerging diseases and new risks.
2. Globalization has connected the world in unprecedented ways, facilitating the spread of pathogens and reducing the effectiveness of political borders in curbing these threats.
3. Limiting the impact of these risks is possible through international cooperation through the establishment of global oversight mechanisms and the development of rapid biomedical response capacity (McInnes, 2016, pp. 388-399).

The fact that science and innovation alone cannot eliminate global health threats reveals once again the importance of bioinformational diplomacy. Today, the emergence and spread of diseases have accelerated with the impact of globalisation, causing pathogens to transcend national borders and become global threats. Globalisation has not only accelerated the spread of pathogens but also necessitated cooperation and data sharing among countries. Through bioinformational diplomacy, a collective response to transnational health threats is created by ensuring the effective sharing of biomedical data between countries. As McInnes emphasises, the establishment of global surveillance mechanisms and the enhancement of rapid biomedical response capacity are essential requirements to make such cooperation effective. However, along with technological innovations, the process also requires credible and inclusive diplomatic efforts. Bioinformational diplomacy can enhance the functionality of these mechanisms by facilitating the sharing of sensitive information, from genetic data to pathogen sequencing, between countries. The GISAID platform has provided a successful example of this process by enabling the rapid sharing of SARS-CoV-2 genomic data, as in the example given by Shu and McCauley (Shu & McCauley, 2017, p. 208).

It is important to use both official and unofficial sources of information in assessing the threat posed by infectious viruses. The global spread of the virus poses a serious threat at the social, economic, and political levels, along with health conditions. Therefore, information and how to obtain it constitute one of the most important factors in preventing and controlling global outbreaks. For example, efforts to understand the origins and source of the Middle East Respiratory Syndrome (MERS) outbreak in 2012 were hampered for several years due to insufficient data and information sharing (McNabb et al., 2014, p. 436). The lost time is accompanied by an increase in casualties, illustrating the importance of information sharing and how delays caused by gaps can jeopardise health security. During the Ebola outbreak in West Africa between 2013 and 2016, the gene sequence of the virus and the causative agent could not be determined due to deficiencies in existing data-sharing mechanisms (Dye, 2016, p. 158). Such data gaps reveal the inadequacy of global cooperation in the fight against the disease and the difficulties of coping with the challenges. In addition to the lack of information and data, countries' attitudes toward information sharing have delayed the implementation of measures against diseases.

Over the past decade, several key stakeholders in the field of viruses have begun to experiment with an alternative model of biodiplomacy. Formally launched in 2008 at the World Health Assembly (WHA), GISAID adopted a data licensing model to address the deeper sensitivities surrounding pathogen sequence data and provide actionable data (Elbe, 2021, p. 669). GISAID's model for these data has encouraged international collaboration and rapid data sharing. According to Choudhuri, the scientists involved in early sequencing efforts to identify the causative agent of the virus hoped that the newly generated data would be freely, openly and quickly accessible

to everyone around the world. A repository called GenBank was established in 1982 to openly share genetic sequence data (Choudhuri, 2014, p. 80). This allows for fast and open international access to the data but prevents others from exercising intellectual property rights over such data, ensuring that the sequence data remains in the public domain. This has been an important step toward the fair sharing of information and data and the acceleration of international cooperation. According to Ferry and Sulston, this transparency will make it impossible to obtain patents (Ferry and Sulston, 2002, p. 300). GenBank does not impose any restrictions on the use of genetic sequence data stored in its database, and anyone with access to the internet can download the sequence data they want free of charge and anonymously by the National Center for Biotechnology Information in cooperation with the International Nucleotide Sequence Database (GenBank, 2019). This kind of open data sharing and ease of access is critical for finding solutions to outbreaks on an international scale.

Early scientific expectations for the timely, open and unrestricted sharing of genetic sequence data came under considerable international political pressure when it became clear that infectious disease outbreaks could not be prevented. For example, when the deadly H5N1 avian influenza virus was detected in Asia in 2003, open data sharing models ran into difficulties, triggering international concern that the world was on the brink of a disruptive innovation. It quickly became clear that some governments experiencing H5N1 outbreaks were reluctant to make publicly available the genetic sequence data of the virus causing the outbreak, raising concerns about losing intellectual property potentially tied to the sequences. This shows that states' attitudes toward data sharing have a direct impact on international health security. The World Health Organisation (WHO) has made a diplomatic effort by creating a password-protected database at the Los Alamos National Laboratory in the United States, accessible only to a select number of scientists. However, this met with resistance from other scientists who argued that without access to the data, they could not contribute to pandemic preparedness efforts. This clearly demonstrates the importance of collaboration among scientists, governments, and industries. The H5N1 pandemic threat, in particular, has shown that scientists, governments and industry play a key role at the international level during pandemics (Elbe, 2021, p. 665).

Rapidly spreading viruses such as COVID-19 have posed a major global threat, infecting millions of people and causing serious mortality. Outbreaks such as Middle East Respiratory Syndrome (MERS), Ebola and Zika have similarly disrupted lives, livelihoods and economies in different parts of the planet. However, advances in science and technology are making it possible to develop more effective means of protection against such harmful outbreaks. Xiaoyu (2020, p. 23) emphasised the rapid expansion of biotechnological research in the aftermath of the COVID-19 pandemic and the important role of digital platforms in this fight. For example, within the scope of bioinformational diplomacy, the rapid sharing of COVID19 genomic sequencing data strengthened

international collaboration and accelerated vaccine development (Young et al., 2020). Mobile health applications have become integral to this process, with features such as contact tracing and symptom monitoring serving as digital diplomatic channels for international data sharing and coordination. Under the concept of "Digital Health Diplomacy," Godinho et al. (2021) emphasise that digital platforms not only transmit health data but also play a vital diplomatic role in international negotiation and trust-building. Thus, beyond its technical aspects, data exchange conducted via mobile platforms has evolved into a diplomatic practice that fosters transnational trust and cooperation.

Along with biotechnology and scientific advances, digital technologies are also incorporating health information-based social media. Global bioinformational diplomacy, in which world governments, pharmaceutical industries, academia, local governments and other non-state actors play an important role, has become capable of determining health policies worldwide. Due to these developments, biotechnology-based information sharing has become a global arena for information warfare.

Bioinformational diplomacy both overlaps with and diverges from similar forms of diplomacy. For instance, while health diplomacy aims to make public health, medical aid, and services subjects of interstate negotiation within the framework of international relations, digital diplomacy refers to public diplomacy conducted through technological tools. The subject of this study, bioinformational diplomacy, lies at the intersection of these two fields—encompassing data exchange through digital infrastructures on one hand, and on the other, focusing on the potential impact of such data on health policy. Thus, bioinformational diplomacy represents the realm in which scientific data sharing becomes a diplomatic tool, reshaping power relations in global health. In this context, biotechnology-based information sharing has evolved into a global "information war" arena marked by competition and hegemonic struggles. Health-related data have acquired diplomatic value, and their secure and equitable distribution has become directly linked to global health security.

Method

The study examines bioinformational diplomacy and international public relations activities during the global impact of the COVID-19 pandemic through mobile applications. The study adopts a qualitative approach and uses the document analysis method. Document analysis is an effective technique for systematically examining texts and revealing relevant themes and patterns. According to Yıldırım and Şimşek, the application of this method allows in-depth analysis of existing documents and helps the researcher to have a broader perspective on a subject (Yıldırım & Şimşek, 2018, p. 189).

During the research, a comprehensive literature review and data collection process was conducted by using multiple data sources. The data were collected from four

main sources. These sources are: official websites and application platforms, academic literature, reports of international organisations, and news sources. Information on mobile applications developed during the search for solutions to the pandemic was obtained from official websites and application platforms. Applications on application platforms such as Google Play and Apple App Store were examined by combining them with the explanations on the websites of the ministries of health and official organisations. These applications also serve an important function in sharing health-related information with the public and establishing a global communication network by collecting user data.

The academic literature provides in-depth knowledge on topics such as theoretical and practical approaches to bioinformational diplomacy and public relations. Academic studies and theses in the literature provide a broad understanding of the effects of the mobile applications developed. In these periods when digitalisation in the field of health accelerates as a global trend, the relationship between mobile applications and public relations strategies becomes an important research topic. The literature included in the scope of the research reveals the communication established by mobile applications with the public since the beginning of the pandemic, the data collection methods of users and the way the data obtained are processed according to ethical standards.

Open-access reports published by international organisations constitute an important source of data. COVID-19-related reports published by organisations such as the World Health Organisation (WHO) and the European Centre for Disease Prevention and Control (ECDC) reveal the role of mobile apps in sharing biodata and the impact of this information on global health policies. These reports emphasise the role of apps in strengthening health information sharing between countries beyond their data collection and monitoring functions. It is clearly seen that mobile applications occupy an important place in terms of providing the public with accurate information. News sources constitute another important data source for the research. News and press releases obtained from reliable national and international media organisations shed light on the effects of mobile applications in the context of public relations and the perceptions of users. The primary analysis elements of the research are the ways in which the role of the media in public health practices and bioinformation diplomacy was shaped during the pandemic, as well as the success of these practices and the evaluations made on the public's trust in them. In the process of analysing the data obtained, data on mobile applications were collected from the identified sources, and these applications were categorised into various categories. Coding was done by taking into account the purposes, functions, data sharing methods and roles of the applications in terms of public relations. During the coding phase, the ways in which the applications serve bioinformational diplomacy and international public relations were determined and thematised. In line with the themes identified, the contributions of the applications to international health diplomacy processes and their functions in terms of public relations strategies were examined in detail.

The present study aims to examine the roles that mobile health applications assumed within the context of international health diplomacy during the COVID19 pandemic. Accordingly, it addresses three primary research questions: first, how mobile health applications contributed to countries' diplomatic cooperation during the pandemic; second, how these applications facilitated diplomatic interactions through biomedical data sharing; and third, what functional contributions these applications made within the framework of bioinformational diplomacy and how these contributions can be understood in the context of international public relations. By exploring these questions, the analysis reveals that mobile applications serve not only as technological tools but also as strategic platforms endowed with diplomatic functions for communication and information exchange. The study's sample is confined to mobile health applications that gained widespread global use, received official recognition, and stood out in terms of bioinformational data sharing during the COVID19 pandemic (March 2020–December 2021). This period was selected as it marked the most intensive phase of data exchange related to international public relations and bioinformational diplomacy. Source selection and document review procedures were conducted according to explicit methodological protocols. A qualitative data analysis process was implemented using the trial version of MAXQDA 2024 software. The content of the selected applications was coded through thematic content analysis, with initial codes generated via precoding, followed by theme development through the identification of recurring patterns. The study systematically examines mobile health applications from 15 countries through official websites, app stores, academic publications, and international reports. The dataset is categorised into four main groups: government statements, application content, academic sources, and credible media reports. Documents were selected based on their development during the COVID-19 pandemic, their relevance to public health data, and their engagement with themes such as digital diplomacy, public relations, or data security. To clarify the analytical process, qualitative content analysis and thematic analysis techniques were employed in a complementary manner. Initially, meaningful textual units related to the research questions were identified through content analysis. These units were then transformed into open codes and grouped based on conceptual similarities. Subsequently, the analysis followed the six-phase thematic analysis framework proposed by Braun and Clarke (2006): familiarisation with the data, generating initial codes, identifying themes, reviewing themes, defining and naming themes, and producing the report. As a result of this process, three main themes were identified: "Purposes and Functions", "Data Sharing Methods", and "Public Relations Roles". The coding and theme development process was conducted using MAXQDA 2024 software, ensuring transparency and methodological rigour throughout the analysis. Coding was carried out by the lead researcher and subsequently crosschecked by a second expert to achieve consensus on the final coding scheme. Applications were selected based on their download statistics from Google Play and the App Store, official endorsements from health ministries, and explicit references to bioinformational data sharing in their descriptions.

The coding procedure was conducted as follows:

In the open coding phase, each application was assigned descriptive labels according to categories such as “purpose,” “core functions,” “data collection methods,” and “international data sharing mechanisms.”

In the second phase, these codes were transformed into conceptual maps within MAXQDA and clustered into themes such as “bioinformational diplomacy,” “international cooperation,” and “public communication.”

Finally, through selective coding, thematic subheadings (e.g., “the diplomatic function of data sharing”) were systematically associated to analyse the extent to which the applications served bioinformational diplomacy.

Data sources included mobile app description texts, technical specification documents, references from WHO and ECDC reports, theoretical framework data from academic literature, and trust and perception analyses pertaining to mobile applications from global news agencies. This approach facilitated a clear definition of the sample and ensured the transparency and reproducibility of the data analysis process.

Data related to the mobile applications was collected from identified sources during the analysis stage and subsequently categorised. Coding was conducted based on the applications’ purposes, functions, data-sharing methods, and roles in public relations. During this phase, the ways in which the applications serve bioinformational diplomacy and international public relations were identified and used as thematic categories. According to these established themes, the contributions of each application to international health diplomacy processes and their roles in public relations strategies were examined in detail. In light of the findings, the contributions of mobile applications to bioinformational sharing and governmental public relations strategies were discussed. The increasing significance of such applications during the COVID19 pandemic underscores that mobile health technologies have become an effective global tool for interaction. The study reveals that mobile applications support the digitalisation of healthcare and provide important insights into how these digital tools have contributed to intergovernmental cooperation in bioinformational sharing.

Findings

Within the scope of the research, the list of mobile applications used during the COVID-19 pandemic was determined. The apps were identified through official websites, ministries of health, and app stores of various countries. These mobile apps provide important examples of how data sharing and public relations strategies are shaped in the fight against the COVID-19 pandemic. Below, we present the data collected on these apps:

Table 1. Covid19 Pandemic Mobile Applications of Countries		
Country	Application Name	Function/Purpose
Türkiye	Life FitsHome	Contact tracing, display of high-risk zones, and generation of HES codes.
England	COVID Symptom Tracker	Symptom tracking and monitoring the spread of the pandemic, developed by King's College London.
India	Aarogya Setu	Contact tracing, risk assessment, and dissemination of public health information.
Hungary	Virus Radar	Contact tracing, symptom reporting, and quarantine tracking.
China	Alipay	QR code–based health pass and travel tracking system integrated within a broader payment platform.
Latvia	Apturi Covid	Contact tracing and potential exposure notifications.
Norway	Smittestopp	Contact tracing and information sharing, with emphasis on personal data anonymity.
Russia	Social Monitoring	Tracking movements of quarantined individuals, developed specifically for Moscow.
Czech Republic	eRouška	Contact tracing and potential exposure alerts.
Germany	Corona-Warn-App	Bluetooth-based contact tracing and risk notifications.
France	StopCovid	Contact tracing and risk alerts, later rebranded as TousAntiCovid.
Egypt	Seha Masr	Symptom tracking, health advice, and services such as hospital appointments.
Singapore	TraceTogether	Bluetooth and QR code-based contact tracing, functions via app or token.
Japan	COCOA	Contact tracing and exposure notifications.
Denmark	Smittestop	Contact tracing and infection risk alerts.

Hayat Eve Sığar is a mobile application that has been widely used in Türkiye to provide public health information during the COVID-19 pandemic. According to Ministry of Health reports, the number of app users exceeded 20 million by the end of 2020 (Ministry of Health, 2020). The aim of the app is to enable users to track known and declared COVID-19 symptoms and identify their contacts. In addition, the app aims to raise public awareness by informing users about risky areas according to the spread of the virus. By collecting anonymised health and location information, the app allows health authorities to analyse this data instantly and helps to take measures to protect public health (Hürriyet, 2020). The Hayat Eve Sığar app has developed strategies to increase the reliability of Türkiye's healthcare system by continuously informing the public through proactive public relations strategies.

The COVID Symptom Tracker is a health app for people living in the United Kingdom. A study by King's College London revealed that the app had over 4.5 million users

by 2020 (King's College London, 2020). The main purpose of the app is to collect data by enabling app users to record their COVID-19 symptoms daily. The data collection process provides important contributions to epidemiological research and serves as a source of information about the spread of COVID-19. App users voluntarily share their personal health information, and the data are anonymised and used to create scientific datasets (BBC News, 2020). The COVID Symptom Tracker app raises awareness of the pandemic by informing the UK public about healthy living through proactive public relations strategies. The Aarogya Setu app, developed by the Indian government, has had a high user base during the COVID-19 pandemic. By 2020, the Government of India announced that the app had surpassed 100 million downloads (Government of India, 2020). The app allows users to track COVID-19 symptoms, identify their risk of exposure to the virus, and learn about testing centres. It collects anonymised personal and health information and transmits it to India's health system. This allows for immediate public health action. As part of the Indian government's public relations strategies, Aarogya Setu conducted proactive public information work, informing the public about the COVID-19 pandemic and conducting awareness campaigns (The Times of India, 2020). The Virus Radar app was developed in Hungary to provide COVID-19 contact tracing. As of 2020, the app was reported to have 1.5 million users (Government of Hungary, 2020). The app allows users to track COVID-19 symptoms and report contacts, informing users about the testing and quarantine processes. The app allows users to voluntarily share their location and health status, which is anonymised and transmitted to health authorities. The data is the basis for taking public health measures. In addition, the app enhances public safety by creating transparency and trust in public relations (Government of Hungary, 2020). Alipay is an app that has emerged as one of China's most frequently used digital payment platforms. During the COVID-19 pandemic, the app provided financial services as well as health information and monitoring services. As of 2020, the total number of Alipay users was reported to be around 1 billion (Alipay, 2020). The app secures travel and social interactions by offering a "code green" application that allows users to monitor their COVID-19 health status. The health data obtained are anonymised, collected and shared with health authorities. The app is used as part of the Chinese government's public relations strategies to promote public health and help society cope with the crisis (Alipay, 2020). Latvia's Apturi Covid app has emerged as an important tool in the fight against COVID-19, providing contact tracing and symptom tracking. As of 2020, the number of app users was recorded to have exceeded 500,000 (Apturi Covid, 2020). The app collects the anonymised health data of its users and shares it with health authorities. Based on the findings, the Latvian government informs the public, develops trust-building strategies and takes steps to improve public health (Apturi Covid, 2020). Norway's Smittestopp app was designed as a digital solution to protect public health during the COVID-19 pandemic. As of 2020, the number of users of the app was reported to be over 1.2 million (Government of Norway, 2020). Smittestopp provides virus-related information by tracking the contact history of app users and collects anonymized location data. This data is shared with the state health

authorities. The app proactively provides guidance on safe social interactions and implements trust-building strategies to keep the Norwegian public safe (Government of Norway, 2020). The Social Monitoring app developed in Russia has reached a large user base with its contact tracing and health status monitoring functions during the COVID-19 pandemic. As of 2020, the app has 20 million users (Government of Russia, 2020). The app allows users to track their symptoms, monitor their health status, and share their data to protect public health. While users voluntarily share their health and location information, the data are anonymised and analysed. Through proactive public relations strategies, the Russian government keeps its people informed and strives to build trust (Government of Russia, 2020). The eRouška app, developed in the Czech Republic, was used for contact tracing and health status monitoring during the COVID-19 pandemic. In 2020, it was announced that the number of users of the application reached 3 million (Government of the Czech Republic, 2020). eRouška aims to minimise the risk of spreading the virus with its contact tracing function while helping users track COVID-19 symptoms. Users' location information is anonymised, collected and reported to health authorities. Through proactive public relations strategies, the Czech government informs the public about health measures and aims to protect public health (Government of the Czech Republic, 2020). Germany's Corona-Warn-App has emerged as an important tool in the fight against COVID- 19, reaching 27 million users by 2020 (Government of Germany, 2020). The app informs users about situations where they have come into contact with COVID-19 and sends alerts to people in high-risk areas. Anonymised data are shared with health authorities and used to track the spread of the pandemic. The German government built public trust and awareness through proactive public relations strategies (Government of Germany, 2020). France's StopCovid app is a digital health tool developed to track contact tracing and virus transmission risks during the COVID-19 pandemic. In 2020, it was reported that the app reached 2 million users (Government of France reports, 2020). The application collects anonymised health data and undertakes the task of transmitting the data to health authorities (Government of France, 2020). The functions of the StopCovid app are to inform app users about the risks associated with the virus and to protect public health. The French government is implementing various public relations strategies to proactively communicate with the public through the app to ensure the safety and informed guidance of the public (Government of France, 2020). These strategies help the public cope with the crisis by guiding them to engage in safe social interactions. The Seha Masr app, developed in Egypt, was used to provide health information during the COVID-19 pandemic and reached 4 million users in 2020 (Government of Egypt reports, 2020). The app aimed to enable users to track their COVID-19 symptoms, learn about testing centres, and have easy access to healthcare services (Government of Egypt, 2020). App users voluntarily share data about their health status, and anonymised data are transferred to health authorities (Government of Egypt, 2020). Seha Masr protected public health in line with public relations strategies and contributed to raising public awareness through proactive information activities. These strategies guide the society more

effectively and safely in the fight against the COVID-19 pandemic. The TraceTogether app in Singapore was developed to provide COVID-19 pandemic contact tracing with approximately 2.5 million users in 2020 (Government of Singapore reports, 2020). The application allows users to quickly perform contact tracing and testing by recording the people they have been in close contact with (Government of Singapore, 2020). If contact risk is detected in application users, the relevant health authorities are contacted, and anonymised health and location information is collected (Government of Singapore, 2020). TraceTogether is part of the Singapore government's public relations strategy to build trust and contribute to public health (Government of Singapore, 2020). The COCOA app in Japan was developed to enable contact tracing during the COVID-19 pandemic and reached approximately 12 million users by the end of 2020 (Government of Japan reports, 2020). The app helps users track their symptoms and trace their contacts (Government of Japan, 2020). Users' location information is anonymised, collected and shared with health authorities (Government of Japan, 2020). COCOA was used as part of the Japanese government's public relations strategies to inform the public and ensure public safety in the fight against the COVID-19 pandemic (Government of Japan, 2020). The Smittestop app in Denmark was developed for contact tracing and symptom monitoring during the COVID-19 pandemic. By 2020, it was reported that the app had reached approximately 2 million users (Danish Government reports, 2020). The app provides users with easy access to information about the pandemic and helps them monitor their health status (Government of Denmark, 2020). Users' location and health data are anonymised, collected and shared with health authorities (Government of Denmark, 2020). The Danish government has used the app to inform the public about safe health practices (Government of Denmark, 2020). The findings obtained from the identified practices were coded in terms of their purposes, functions, data-sharing methods and roles in terms of PR. The themes and explanations of the themes identified during the coding process are as follows:

Objectives and Functions:

Public information and guidance: These apps aim to raise awareness of health risks by informing users about COVID-19.

Symptom and contact tracing: Some apps aim to control the spread of the disease by tracking users' symptoms and identifying contacts.

Detection of risk areas: The applications provide users with information about risky areas, enabling them to take precautions with advance warnings.

Ease of access to health services: Some apps have aimed to speed up access to health services and provide easy access to health information.

Data Sharing Methods:

Voluntary user data: The apps collected and used users' health and personal data on a voluntary basis.

Anonymised health and location information: Anonymised data were used to ensure data confidentiality.

Real-time data flow: Apps have helped monitor the pandemic by sharing COVID-19- related data in real time.

Public Relations Roles:

Proactive communication with the public: Practices communicated directly and effectively with the public, ensuring accurate information flow.

Positive image building and trust building: Many practices have focused on building trust as part of government public relations strategies.

Crisis management and information strategies: Practices contributed to crisis management processes by informing the public during the pandemic and supported the public relations strategies of states during the crisis period.

Table 2. Thematic Coding Table (with Sample Applications)

Theme Title	Subcategory	Sample Codes	Sample Application / Country
Purposes and Functions	Public Information and Guidance	Risk alerts, health advice, informative notifications	Hayat Eve Sığar (Türkiye): Displaying risk zones on a map
	Symptom and Contact Tracking	Symptom reporting, contact notification, isolation warning	COVID Symptom Tracker (UK): Daily symptom tracking
	Identification of High-Risk Areas	Location-based risk maps, red zone notifications	Alipay (China): Monitoring health status and travel history via QR code
	Facilitated Access to Healthcare	Test center guidance, health consultations	Seha Masr (Egypt): Providing access to healthcare services
Data Sharing Methods	Voluntary User Data	User consent, acceptance of terms, voluntary data sharing	Aarogya Setu (India): Data sharing based on user consent
	Anonymized Data	Anonymous GPS data, de-identified symptom information	Corona-Warn-App (Germany): Anonymous contact tracing via Bluetooth
	Real-Time Data Flow	Live alerts, instant case sharing, time-stamped data	Smittestop (Norway): Real-time sharing of contact data
Public Relations Roles	Proactive Public Communication	İnformative messages, mobile alerts, frequently updated content	TraceTogether (Singapore): In-app explanations and public announcements
	Trust and Image Building	Official government logo, personal data assurance, transparency	eRouška (Czechia): Building trust through transparency policies
	Crisis Management and Information Strategy	İntegration with public statements, emergency notifications	StopCovid (France): Direct information flow in crisis management

The findings show that mobile applications make significant contributions to the sharing of bioinformational information and affect the international public relations strategies of states. These applications can be used effectively as a tool of biosocial diplomacy in global health crises and encourage international health cooperation. The results show that during the global pandemic, the applications provided multidimensional contributions to public relations and crisis management processes as well as healthcare activities. Functions such as informing the public, symptom tracking, and identifying risky areas were found to be effective in protecting public health and minimising health risks. Mobile apps have increased individual contribution to outbreak management by using mechanisms that encourage individuals to voluntarily share their health information. The use of anonymised health and location data has enabled real-time monitoring and analysis while protecting data privacy. This demonstrates how technology can be used effectively in controlling the spread of the pandemic.

The pandemic, which spread around the world and brought about the search for international solutions, revealed that mobile applications play an important role in terms of public relations. These applications, developed as an important solution tool, contributed to crisis management processes in establishing a trust-based communication with the public and supported governments to create positive images with proactive information and accurate information flow. As part of the public relations strategies of governments, these practices facilitated gaining public support in times of crisis.

The data obtained from the research show that these applications are tools that can be used in international health diplomacy processes as well as in local crisis management. By promoting international cooperation, mobile applications have shown that they can be considered part of bioinformational diplomacy. In particular, the sharing of anonymised data has created a new paradigm in international health cooperation and information exchange. Mobile apps have functioned as a critical tool for public health management and public relations during the COVID-19 pandemic and similar global health crises. This situation shows that solution-oriented applications can be used more effectively in similar crises in the future by strengthening the role of technology in health management and crisis communication processes. The facilitating effects of mobile applications on international cooperation also highlight the need to develop more comprehensive and integrated solutions for potential future health crises.

In this context, the roles undertaken by mobile health applications during the COVID-19 pandemic directly address the research questions identified in the study. These applications, through their data-driven structures, have supported not only individual health management but also the health diplomacy processes of states based on international cooperation. Specifically, practices such as the collection of voluntary

user data and the sharing of anonymized health and location information on international platforms have enabled trust-based digital interaction between countries and operationalized the core components of biocognitive diplomacy. Moreover, the functions of these applications—such as trust building, transparency, the development of data standards, and public awareness—have allowed governments to present a positive image both to their domestic publics and to the international community during times of crisis. From a public relations perspective, the applications have functioned as strategic communication tools in proactive information dissemination, risk communication, and crisis management processes. Thus, they have become integral elements of digital diplomacy practices that reinforce public support. The findings suggest that mobile applications can serve as effective tools of digital diplomacy at both individual and transnational levels in future global health crises.

Conclusion

Mobile applications have functioned as important digital health tools supporting public health at the national/international level during the COVID-19 pandemic. Applications have played critical roles in bringing the pandemic under control, informing the public and reducing the burden on health systems. Examples such as Türkiye's "Hayat Eve Sığar" application and the UK's "COVID Symptom Tracker" have been effective in building community resilience against the pandemic and strengthened the individual contributions of the public (Ministry of Health, 2020, p. 2; Hall, 2020, p. 124; COVID Symptom Study, 2020, p. 3). Mobile applications have been rapidly deployed in global health crises, enabling effective public health interventions. Data sharing has strengthened international cooperation in the context of bioinformational diplomacy and has led to rapid solutions to epidemiological problems. The findings of the study demonstrate that mobile applications have become strategic tools not only for national health interventions but also for global health diplomacy. This aligns with the literature presented by Godinho et al. (2021) and Kondylakis et al. (2020), which emphasises that mobile applications have evolved into instruments of bioinformational diplomacy through international data sharing and contact tracing, fostering digital trust between governments and international organisations. The flow of data has not only served as an epidemiological tool but has also transformed into a platform for international trust and cooperation, thereby exemplifying a tangible form of digital diplomacy. As demonstrated by Kondylakis et al. (2020, p. 124), these practices have facilitated access to healthcare services by reducing the workload of hospitals. In addition, as in the case of Iran, it has been possible to monitor and analyse the health status of users through individual data sharing (Gilbert, 2020, p. 129). By supporting information sharing across national borders and contributing to the global health chain, applications have also been considered effective tools in terms of public relations. Technology-supported applications that offer innovative

solutions, such as IBM's Health Pass, have been effective in building international trust and facilitating travel along with health management. In addition, they have contributed not only to individual health monitoring but also to taking preventive steps toward improving public health. The UK Deputy Health Minister Professor San-Tam's announcement that loss of taste and smell were added to the symptoms of the COVID-19 pandemic based on the data provided by the apps clearly shows the contribution of governments to pandemic management (Kanbir and Sanmartin, 2020, p. 25). However, emerging concerns about data security and privacy have posed significant challenges that may affect the use of apps. Handicaps such as data breaches and a lack of transparency can undermine public trust in apps and data-sharing processes that are critical for pandemic management. It is therefore crucial that future apps are developed with systems that respect users' privacy rights more and are based on transparent operating mechanisms. Mobile applications have come to the fore as effective and innovative tools to support public health and facilitate management during global crises such as the COVID-19 pandemic. In terms of purposes and functions, they have fulfilled critical operations such as informing and guiding the public, tracking symptoms and contacts, identifying risky areas and facilitating access to health services. These applications have increased the accessibility of healthcare services by supporting individuals in making informed decisions regarding the pandemic. Data sharing methods provided fast and accurate information flow in the fight against the pandemic based on the collection of voluntary user data, the use of anonymised health and location information, and real-time data flow. Real-time data provides information to health professionals and the public to be informed quickly. These methods enabled healthcare professionals to understand outbreak dynamics and the public to be informed in real time. However, concerns about data sharing and security pose significant challenges to the long- term acceptance and sustainability of such applications. In the future, stronger regulations on data security and methods that do not violate the privacy of users will increase the effectiveness of applications proposed as a solution in possible health crises and ensure public trust.

In terms of public relations roles, the practices contributed to proactive communication with the public during crisis management processes, creating a positive image and building trust. The public was encouraged to participate in the practices through accurate information strategies before, during, and after the crisis periods. Proactive communication strategies increased public trust and reinforced the determination of governments in pandemic management. These practices were seen as a way of establishing safe and transparent communication with the public and promoting social solidarity in the fight against the pandemic.

Mobile health applications have evolved far beyond mere technological tools to become core instruments of bioinformational diplomacy and public relations strategies. By strengthening data privacy and security standards, prioritizing user-friendly

design, and ensuring equitable access, these tools foster trust-based infrastructures essential for crisis resilience. In future health emergencies, such applications will remain vital in safeguarding individual and collective health security by offering innovative, responsive solutions. However, concerns regarding data sharing and security necessitate robust safeguards to secure long-term adoption and sustainability. Ensuring data privacy and protection is, therefore, paramount for the success of future digital interventions.

Our findings show that mobile health applications can serve as diplomatic instruments within bioinformational diplomacy. They act not only as conduits between individuals and health authorities but also as diplomatic actors in international data exchange, cooperation, and trust-building. This aligns with Stefan Elbe's concept of "bioinformational diplomacy," where the flow of biomedical data is simultaneously scientific and political-diplomatic (Elbe, 2021). Features such as symptom tracking, contact alerts, and location notifications facilitate both individual and collective biodata production, supporting Tollefsen's (2017) argument that international scientific trust is built through data sharing.

National apps like those from Türkiye, Germany, Singapore, and India that contribute data to global platforms like GISAID demonstrate their direct diplomatic utility. By promoting voluntary data sharing, these tools activate societal trust mechanisms, underscoring the strategic significance of public relations in national and international trust-building. Fleming et al. (2020) note that data security concerns can limit public participation in mobile apps—a finding we replicate, showing that public trust directly affects adoption rates. Beyond public health goals, these apps serve paradiplomatic functions—supporting intergovernmental collaboration, sharing technical infrastructure, and exchanging crisis-management knowledge (Batal & Tuğlu, 2018). Notably, Norway's Smittestopp app became a regional model, and India's Aarogya Setu contributed data to WHO initiatives. As Elbe (2021) asserts, scientists have become both knowledge producers and "informal diplomats."

Building on past pandemic responses, our study demonstrates the critical role of mobile apps in public health crises. To maintain their effectiveness, future apps must prioritise data security and uphold user privacy. Supported by bioinformational diplomacy, mobile health tools bolster public health systems and international cooperation. Maximising their potential will require constructive collaboration among governments, health authorities, and technology firms. By addressing technological disparities and adopting ethical data-sharing standards, these apps can serve as both technological platforms and diplomatic spaces. The pandemic has revealed how digital health tools, combined with multi-actor governance, can build trust, enhance health literacy, and support international cooperation. Recommendations for sustainable bioinformational diplomacy and effective mobile health applications include:

1. **Data Privacy and Security**: Establish strong regulations that protect users' privacy rights.
2. **International Cooperation**: Develop inclusive cooperation mechanisms between states to enhance the effectiveness of bioinformational diplomacy.
3. **User-Friendly Designs**: Prioritising user-friendly designs to increase the accessibility of mobile applications and ensure that they can be used by all segments of society.
4. **Fair/Equal Information Sharing**: Fair and equal sharing of health data within the framework of ethical principles and in a way that supports public health.
5. **Equity in Technology Access**: Initiatives to improve economic and social infrastructures for the use of technological facilities and infrastructure.
6. **Education and Awareness**: Governments organise training programs to increase communities' awareness of digital health tools and promote their proper use.

Türkiye's contributions in this field help to develop solutions for regional/global health security. Türkiye's pioneering work on bioinformational diplomacy can shape both regional and global health policies. For example, Türkiye's support and contributions to vaccine development processes during the COVID-19 pandemic provide a practical example of bioinformational diplomacy (TÜBİTAK 2021). Developing policies to demonstrate the inclusiveness of bioinformational diplomacy can make significant contributions to efforts to ensure global health security by increasing the effectiveness of responses to international health crises.

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