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DIGITAL CONTACT TRACING APPLICATION – KORONAVILKKU FOR COVID – 19 EPIDEMIC PREVENTION AND CONTROL

A narrative literature review

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THESIS
Abstract

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Abstract

The primary objective of this study was to examine the existing literature on clinical and practical COVID-19 pandemic preventive measures, in particular Finland's contact tracing app "Koronavilkku". The research method of this study was a narrative literature review. The data was collected from PUBMED, EBSCO (CINAHL), SCIENCE DIRECT and GOOGLE SCHOLAR. Data from 7 studies were used in this study. The results indicate that technical, social, and epidemiological methods were the three categories where digital contact tracing applications were deployed in response to COVID-19 epidemic prevention and control. The findings of the narrative literature study indicate that the Finnish digital contact and monitoring application played a crucial part in the COVID - 19 epidemic's prevention and control. Contact tracking applications used during the COVID-19 outbreak has given new insights for modernizing the idea of digital health, relating to person - centred treatment, financial incentives, and cybersecurity. The COVID-19 pandemic is not merely a human tragedy. The lessons learned offer workable, preventative, and control measures for future disease outbreaks.

Keywords

Digital contact tracing application, Koronavillkku, COVID – 19 pandemic, Prevention and control, Review

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1 INTRODUCTION

Late in December 2019, Wuhan, China, saw the emergence of the 2019 coronavirus (COVID-19), which began swiftly spreading throughout the world in March 2020. (WHO, 2020). Since 2019, the outbreak-related worldwide pandemic has triggered a public health crisis unseen in almost a century. The COVID-19 pandemic has been a major driver for the wider use of digital healthcare tools (U.S. Food and Drug, 2020).

In 2020, with the COVID - 19 global epidemic outbreak, various countries generally felt that tracing contacts of an infected person with existing methods was relatively overly labor-intensive. It was difficult to check and confirm all personnel as movement was inevitable. Under such circumstances, tracing possible infected contacts in a time- and labor-saving manner without affecting users' privacy become particularly important. Therefore, in the beginning of 2020, the public epidemic prevention departments of various countries hoped to use scientific and technological means to make new attempts to track and cut off the transmission chain. Many chose the COVID - 19 contact tracking applications based on Bluetooth technology (Kwet, 2016).

In 1998, Bluetooth was initially introduced. The COVID-19 pneumonia epidemic prevention and control technology, which is dependent on Bluetooth communication participatory mobile device identification, is being utilized widely in various nations and areas. Both a wireless communication protocol and a standard for wireless technology exist in Bluetooth. The gadget features a cheap transceiver chip with a limited transmission range and minimal power requirements. It enables the construction of personal area networks and the exchange of short-range data between fixed and mobile devices. Features include typical mobile phone installation, strong penetration, and precise short-range transmission and placement. International Mobile Equipment Identity is referred to as IMEI in English. The mobile phone's ID number, or IMEI, is also the global ID number. Compared to cellular signals and GPS, Bluetooth transmission distance could offer more exact location, closer to the distance of the transmission range. It does not track the user's location but instead tracks the spread of the infection through their close relationships with other users. Only the user's personal mobile phone retains the IMEI identifier of the encrypted conversation. After verifying the user's consent, information can be uploaded. Only a unique communication number can be used to link upload data, according to the user's background system (Todtenberg et al., 2019).

Bluetooth positioning data is based on more precise transmissions than GPS-based location data. The user's Bluetooth can automatically look for nearby devices if it is enabled. Existing Bluetooth technology can locate are devices within a dozen meters. Agreed standards between Apple and Google further supports the widespread acceptance of this technology. Additionally, COVID -19 contact monitoring software must expressly get users' authorization before processing sensitive personal data, and its usage is governed by several rigorous laws. In the European Union, individual privacy protections are governed by General Data Protection Regulation (GDPR, 2016) and other national laws.

One of the most effective ways to slow the COVID-19 epidemic's progress is to identify and isolate affected people and their close connections. Against this backdrop, in 2020 the European

Commission issued a statement to harmonize methods for the safety and efficient use of COVID-19 contacts tracking application across the EU. The European Commission noted that voluntary installation of contact tracking apps would help to gradually lift travel restrictions while also regulating the contact tracking applications must ''protect human rights and privacy'', and be "voluntary, transparent, secure, interoperable" (Bonachea et al. 1998). Additionally, geolocation or mobility data should not be collected, and personal data should be anonymized. The interoperability of contact tracing apps was underlined by the European Commission. Each application must adhere to the Commission's guidelines and be completely compliant with all EU data protection and privacy laws. The statement also urged all COVID - 19 contact tracing applications to be used only temporarily. Once the public health emergency is over, they should be discontinued (EC, 2020/5973).

Finland launched its COVID - 19 contact tracking application "Koronavilkku" on August 31, 2020. This narrative research review will examine how Finland's Koronavilkku contact tracing app was used to control the COVID-19 outbreak there. Research will be examined concerning how digital health resources like Koronavilkku were leveraged to stop and limit the COVID-19 outbreak in Finland. Encouraging public use of the coronavirus tracing application to mitigate the impact of the pandemic, the implementation of coronavirus tracing applications for COVID-19 pandemic control, preventing the COVID-19 pandemic, and improving digital health technology initiatives are all necessary to lessen the burden on the healthcare system and ensure the system's proper operation. Lessons learned promise to improve preparation and will lead to improvements in preparation for future epidemic control (THL, 2022).

2 DISCRIPTION AND BACKGROUND

2.1 COVID – 19 epidemics

The World Health Organization (WHO, 2020) designated the coronavirus infection that resulted in pneumonia in 2019 as "2019 coronavirus disease" (COVID - 19). In several hospitals in Wuhan City, Hubei Province, China, multiple instances of pneumonia with no known cause and a history of exposure to the Huanan seafood market have been discovered since December 2019. Since then, these cases have been determined to be acute respiratory infections caused by the 2019 new coronavirus infection (WHO, 2020). Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization, said the coronavirus-caused pneumonia will be known as "COVID-19" on February 11, 2020, in Geneva, Switzerland. Globally, there were 608,328,548 confirmed cases as of September 16, 2022, an increase of 499,868 from the previous day. There were also 1,780 additional fatalities, bringing the total to 6,501,469 cases since the beginning of the pandemic (WHO, 2022). As of September 30, 2022, a total of 1 292 940 coronavirus cases have been diagnosed and 5,981 deaths in Finland during the entire coronavirus epidemic (THL 2022).

COVID-19 immunizations were accessible and widely utilized by the end of June 2021: Adenovirus vector vaccines were created by Oxford University in the United Kingdom and AstraZeneca, a partnership between Britain and Switzerland, as well as Moderna and NIAID in the United States. mRNA vaccines were created by Pfizer in the United States and BioNTech in Germany. Thanks to the creation of the mRNA vaccine, the adenovirus vector vaccine, and the recombinant protein vaccine by Johnson & Johnson in the United States, the total number of COVID-19 vaccines approved for marketing or emergency use has reached 16, and the maximum vaccine production capacity exceeds 15 billion doses (WHO, 2021). As of September 2022, the main vaccines used in Finland are the Pfizer mRNA vaccines, AstraZeneca adenovirus vector vaccines, and the Moderna mRNA vaccines. The vaccination rate was 89.3% for the first dose, 87.3% for the second dose, 65.9% for the third dose, and 19.1% for the fourth dose. (THL, 2022)

The B.1.1.529 coronavirus variant strain, which has many changes that enhance the risk of reinfection with the virus in humans, was the topic of an emergency meeting of the WHO on November 26, 2021. Following the conference, WHO declared it to be a "Variant of Concern" and gave it the name Omicron (WHO, 2021). The number of instances of infection with this mutant new coronavirus Omicron strain accounted for 98.3% of the total number of new confirmed cases of coronary pneumonia (COVID-19) in the US in the week ending January 8, 2022, on January 11, 2022. The US Centers for Disease Control and Prevention reported “Omicron” become the mainstream coronavirus across the world (CDC, 2022).

On December 22, 2021, the US Food and Drug Administration approved Paxlovid, the first oral medication for emergency use in treating coronavirus infection, for the treatment of adults and children 12 years of age and older with mild to moderate symptoms of the coronavirus, as well as for those with people who have a higher risk of developing severe illness (FDA, 2021). On April 21, 2022, the World Health Organization approved the oral COVID-19 drug Paxlovid from Pfizer for use in high-risk COVID-19 patients (WHO, 2022).

In December 2021, the International Council of Nurses stated that the number of nurses around the world is declining further amid the spread of the Omicron strain. In addition, the global distribution of nurses is also uneven as Western countries step up recruitment of medical staffs from Africa and other poorer countries, with wealthy countries having on average, nearly 10 times as many nurses as poor countries (ICN, 2021).

2.2 Definiton of digital health

The design and application of digital technology with the aim of sharing health information and taking part in related activities is referred to as "digital health." This includes using big data, artificial intelligence, and the Internet of Things in the management of health. The World Health Organization originally suggested the idea in the Global Strategy for Digital Health in October 2019 (WHO, 2019). The distinction between traditional offline medical care and digitally enabled medical health will grow hazier as network information technology continues to advance. The evolution of traditional offline medical care into digital, networked, and intelligent digital health is a clear-cut development trend. Health data will be increasingly shared, available, secure, and trustworthy, improving public health. Digital technology will thoroughly connect multiple social entities for common governance and create a worldwide system of resource sharing for the medical and healthcare industries. It has become popular to use digital technology with public health governance in this way. The public health governance structure will be flatter, and the governance process will be more transparent, to realize real-time interconnection, data sharing, linkage, and coordination, promote precise supervision, scientific governance, and modernize the health governance system and governance capabilities (Mesko B et al. 2017).

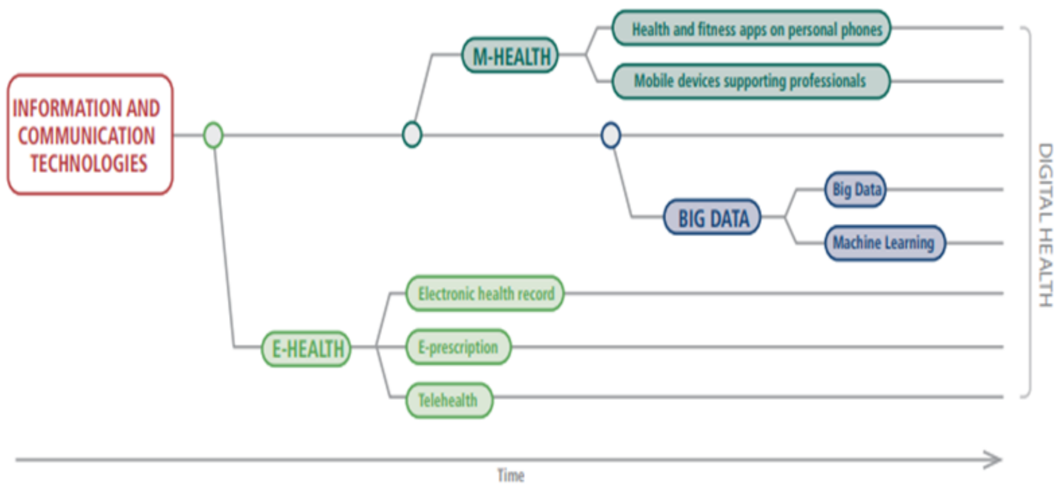

Figure 1 Over time, digital health has expanded to include mHealth, eHealth, and big data (Figure acquired using open access policy from WHO website, 2021)

Digital technologies, including such ‘mHealth’, which emphasizes mobile technology, and eHealth, which uses information and communication technologies in healthcare, place significant focus on both the devices themselves and the data they generate, exchange, and utilize. These many ideas themselves reflect modifications in how information and communication technologies are applied to promote health (Stroehmann et. al, 2011; Meier et. al,2013, 359-382).

Due to industry regulation and other considerations, the health care sector is less balanced and advanced than many other industries in the development and deployment of digital technology in various nations and regions. The COVID-19 epidemic prevention and control effort has made full use of the benefits of digital health services. Since the 2019 coronavirus pandemic began, people have understood the need to avoid the gathering of citizens and physical contact to reduce the risk of cross-infection. Various countries vigorously carried out digital health and medical services, especially digital diagnosis, and treatment consulting services for potentially infected persons. This has led to digital health technologies playing a significant role in COVID - 19 epidemic prevention and control. These measures included health evaluation, health counselling, advice on self-care, follow-up for chronic illnesses, psychological counselling, etc. Digital tools have been used to provide these services, so that the citizens can obtain timely health assessment and professional guidance safely, allowing healthcare professionals to accurately guide patients to seek health care and medical care in an orderly manner, and effectively relieve the pressure of hospital treatment (Powell J et. al 2015).

Digital technologies such as online medical care, remote consultation, 5G, cloud medical care, and AI have been widely used in the coronavirus infected pneumonia epidemic, which has promoted the rapid development of mHealth, eHealth and big data (Widmer et al. 2015, 90: 469 -80).

The adoption of new technologies is generally slow in the healthcare sector due to safety and ethical concerns, and digital health represents a new stage in the evolution of health information technology. The development of information technology in the healthcare sector must be considered to properly understand digital health. Health information technology has steadily transitioned from the usage of huge computers to the era of digital health, bringing significant advancements and improvements to the overall health system that go beyond the technology itself (Edgell, et al. 2020).

The world's first computer was created in the 1940s. At the time, computers were enormous and incredibly costly in terms of both hardware and software. They were mostly employed in the business sector to complete automated tasks that demand a lot of procedure. The usage of apps for auxiliary support tasks, such capturing medical records, is the focus of this discussion. Computers are increasingly becoming smaller because of ongoing software and hardware upgrades, which encourages the growth of the information age. The University of Vermont-Burlington Medical Center started working on PROMIS — Problem-Oriented Medical Information System—in the 1960s. This was the first acknowledged attempt by ICT to create a comprehensive, integrated medical information system in the healthcare industry (Smith, 2015). Systems at the time were provider-centric and did not consider the demands of citizens, patients, or professionals. The barriers between different disciplines are increasingly eroding because of ICT's fast growth and maturity, and more cutting-edge technologies are being introduced into the healthcare industry. Although patient needs are currently receiving more attention, medical and health service providers continue to be the focus of medical information technology. These organizations control most of the data related to medical care and use it to enhance the quality and effectiveness of patient care. Electronic medical records have gained popularity worldwide since 1990. (WHO, 2020).

According to O'Donoghue et al., digital health is a multidisciplinary profession that includes numerous practitioners including doctors, researchers, and scientists with backgrounds in engineering, social sciences, public health, health economics, and data management. A significant role for digital health has been played during the COVID-19 epidemic. Big data-based itinerary information management has been essential in the prevention and management of epidemics. Internet telemedicine overcomes the constraints of conventional space and may eliminate the need for some face-to-face interactions between medical professionals and patients (O'Donoghue et al. 2012).

2020 marks a new beginning for the development of digital health since the danger of COVID-19 infection has decreased. The development of digital health was primarily influenced by two factors: the advancement of technology and the demands of public health. On the one hand, the advancement of digital technology has created a strong framework for the growth of the digital health industry. Realizing digital health is based on the development of information and communication technology in the medical and healthcare fields has brought about an accelerated transition of healthcare from electronic and informatized to digital and intelligent. Based on the benefits of the e-health period, the digital health era has emerged, providing the foundational infrastructure for a new era. However, the requirements for public health have altered. The conventional medical and health business is undergoing significant transformation as the proportion of the ageing population, the frequency of chronic illnesses, and health expenses continue to climb. The way people view health is also evolving all the time. According to the contemporary medical paradigm, health has three facets: physical, psychological, and social. The World Health Organization claims that of the numerous variables affecting health, lifestyle has the most influence. People now anticipate and have greater standards for health (Mariano B, 2020, 98 - 231).

When the idea of digital health first became popular, it was seen as the solution to many medical issues. To sustain health, the entire social group must work together to address health issues, stressing the mobilization of all beneficial and advantageous aspects. The beneficiaries of health outcomes include people, families, communities, and society, hence these groups ought to take part in health initiatives. Digital health now places an emphasis on early illness prevention, precise intervention, and health management, rather than merely disease diagnosis and treatment. A comprehensive, full-cycle health effort requires collaboration between residents and health service providers. The Global Strategy on Digital Health (2020–2025), published by the World Health Organization in 2019, intends to use and promote digital health to attain universal health and assure greater health and well-being for more people (WHO, 2021)

2.3 Definition of COVID-19 contact tracing apps

The COVID-19 apps contain mobile software programs for digital contact tracing. This technology checks a database of known contacts using the phone's Bluetooth and GPS data to see if users have recently had contact with a Covid-19 patient. The government then receives the information (Kwet, 2016). The World Health Organization states that contact tracing involves keeping track of "those who have been in intimate touch with someone who has been infected with the virus," potentially assisting "contacts in accessing care and treatment" and halting "further viral transmission" (WHO, 2020).

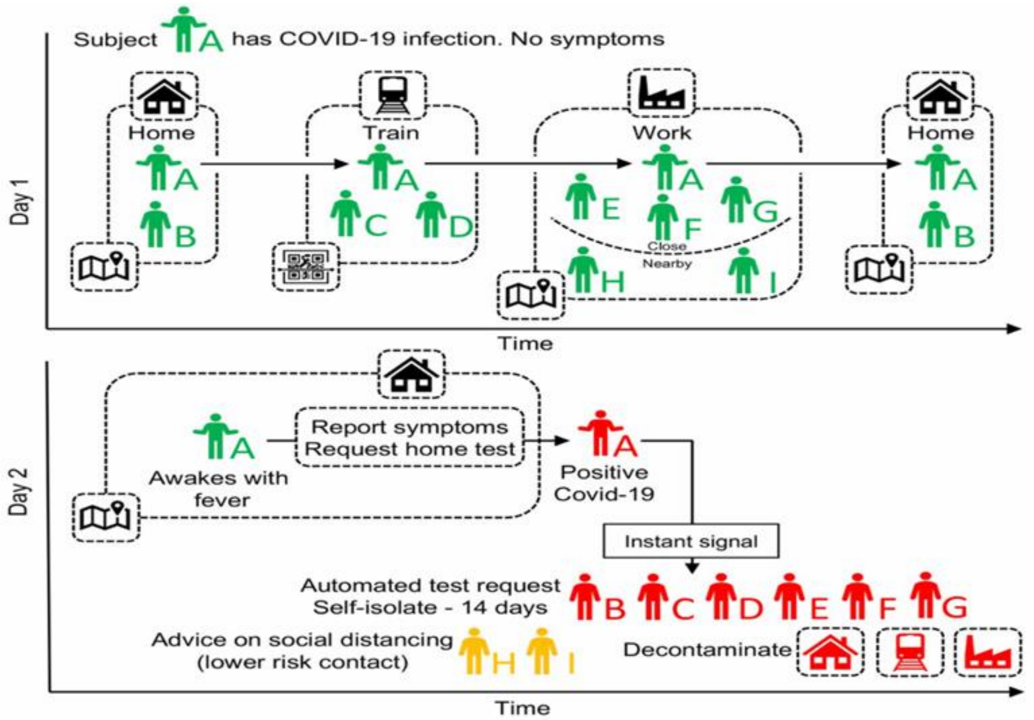

Figure 2 An illustration of COVID-19 contacts tracking using an app (Figure acquired through open access policy from scientific page, 2020).

Figure 2 depicts the system for following up with digital contacts using a mobile app. Healthy persons can still commute and work, as stated in (a), and (b) when person A tests positive, their contacts get a text alert urging them to be tested.

A digital contact tracing program uses a tracing mechanism, frequently based on a mobile device, to identify the contact between a user and an infected patient. The COVID-19 contact tracing app was introduced to the public during the COVID-19 epidemic. These proximity tracing apps have two competing technologies: GPS and Bluetooth, both with restrictions of their own. Additionally, the protocol may be either centralized or decentralized, meaning that a central health authority or a specific client inside the network can manage contact history (Tamar, 2020, 45 - 57).

Citizens have the legal right to voluntarily embrace digital contact tracking applications in most nations and regions, which has led to variations in how these applications are used. The use of smartphone data by the central government to track and influence citizen behavior raises ethical concerns for citizens in addition to technological concerns regarding the efficiency of contact tracking systems. The most urgent problems include ownership, freedom, and monitoring. Different people and countries throughout the world have adopted various stances on this problem (Legal business library, 2020).

Public health experts started looking at novel ways to stop the spread of illnesses when the bacterial hypothesis of disease was clarified in the late nineteenth century. Programs in public health that monitor the transmission of infectious illnesses play a crucial role in infection prevention and epidemic response. Historical evidence suggests that if sick individuals can be located, quarantined, and encouraged to disclose their contacts, epidemics can be slowed down, and in certain cases, prevented. As a result, for almost a century, contact tracing has been widely utilized to combat infectious illnesses. Syphilis and gonorrhea, TB, HIV, Ebola, and more recently COVID-19 are the most common diseases for which contact tracing is utilized (El-Sadr et al. 2022). However, a wide range of techniques fit within the broad concept of contact tracing. These tactics are based on governmental authority to track epidemics, demand that medical professionals and public health organizations report specific diseases, and select people for surveillance, inquiry, and engagement by public health officials. Syphilis was the focus of the first significant contact tracing initiatives, while at the time, tracking STI (sexually transmitted infections) resulted in stigma. STI Tracing asks people to list their sexual connections, which reveals information about those encounters as well as any perceived sins or adultery that may have harmed their marriages, families, other relationships, or jobs. Contact tracking programs are significantly hindered from being widely and effectively used since they may feed syphilis or other STI stigma, fear, shame, and guilt. During the AIDS crisis, public health officials started implementing partner notification programs, emphasizing the individuals' moral accountability for connections and the wellbeing of their sexual partners. Officials became aware that this strategy may impede spontaneous identification of contacts (Brandt, 2022).

The end of December 2019 saw the emergence of the Coronavirus respiratory sickness (SARS-CoV-2). The WHO named the coronavirus infection 2019 (COVID-19) a worldwide pandemic three months later (Cucinotta et al. 2020, 157 - 160). Much research has used search engines like Google and Website big data such as diverse social media to anticipate and warn the public about COVID - 19 sickness, and administrations and health departments in many countries have built national or worldwide official forecasting and contact tracing applications. Along with the COVID-19 epidemic forecast, there are other flu forecasts based on social media, influenza forecasts based on Google Trends, dengue disease projections, and warning systems based on Google Trends, hand, foot, and tongue disease projections and early warnings based on Microsoft Bing Index, South Korea's Middle East Respiratory Syndrome disease forecasts, and early warnings based on GT-based and Twitter user data, etc. (Brandt, 2022).

The COVID - 19 pneumonia surveillance and traceability system primarily consist of several systems, including those for big data epidemic analysis and surveillance close contact demographic tracing and management, and epidemic government services. The system employs big data fusing analysis, mobile Internet, and other technologies to perform fusion calculations on multi-source data, properly pinpoint the epidemic region, examine, and assess the epidemic's growth trend, and support scientific decision-making. The COVID - 19 pneumonia epidemic contact tracing program has created substantial and multi-dimensional epidemic data items, offering strong support for the fusion of information and applications. The arduous quantitative work and daily tasks of the disease management are unified and incorporated through the development of the application, and through close information management, but problems with inaccurate close contact data, the incapability to track change status, the location of personnel who are unknown, and the extremely high level of mechanical statistical data create challenges. The need for effectiveness and precision of prevention and control have significantly increased due to time constraints and other factors (Colizza et al. 2021, 361 - 362).

Internet access enables individuals to rapidly find out what is known about the COVID-19 outbreak, ask questions about it, get online medical advice, and actively report epidemic data. Citizens may lessen the possibility of cross-infection and increase their accurate awareness of the pandemic while accessing medical and health services. This information access may reduce worry and tension. Social media, internet searches, etc. have all contributed significantly to the information available for the tracing of infectious illnesses thanks to the Internet's ongoing development. Big data may be effectively integrated and accurately analyzed to better monitor, detect, and track infectious illnesses. The most pressing need is to create analysis techniques and communicable diseases models that are better suited for complicated data to track, monitor, and warn about infectious illnesses more promptly and precisely (El-Sadr et al. 2022).

2.4 Definition of Corona signal (Koronavilkku)

The Finnish Institute of Health and Welfare created Corona signal, known in Finland as “Koronavilkku”, a mobile application that tracks coronavirus infections by collecting data from nearby Bluetooth devices via short-range Bluetooth signals. Koronavilkku may be installed on devices running the iOS and Android operating systems. Through Koronavilkku, owners of phones will receive information if they have been near someone who has been using the app in the past two weeks and has been exposed to the coronavirus. Koronavilkku was released on August 31, 2020, and by November 5, 2020, it had been downloaded 2,474,900 times (Solita 2020). Due to the Omicron transformation of the coronavirus, the number of infections has increased so much that not all infections are detectable (traceable) by healthcare authorities, and Koronavilkku cannot report all exposures. It was discontinued on June 1, 2022 (YLE, 2022).

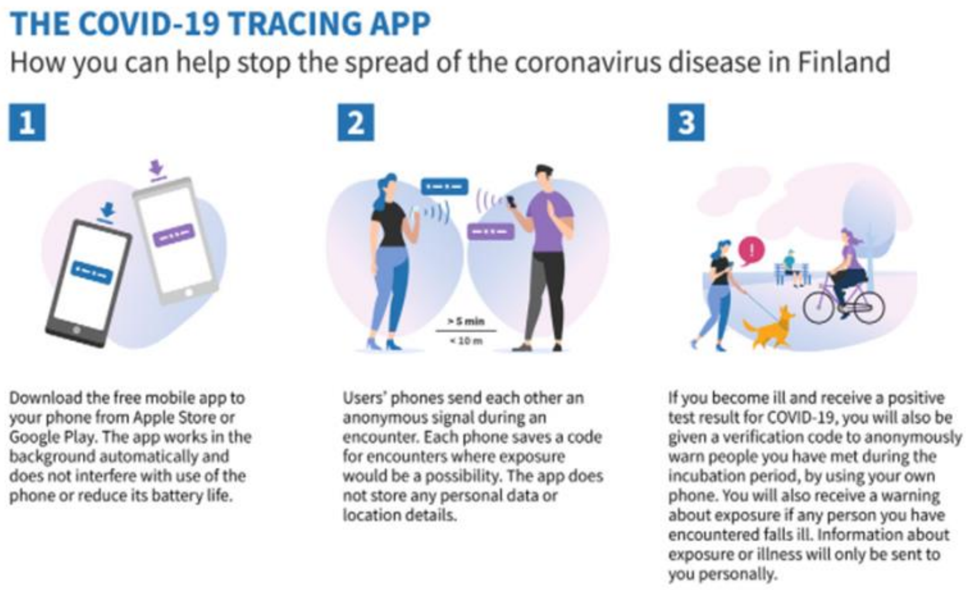

Figure 3 How the Finnish mobile app tracing coronavirus exposure works (Solita, 2020)

Smartphone-based contact - tracing apps come in two flavors. In both cases, the phones broadcast transient pseudonyms, which other phones can record. However, the applications differ after COVID-19 is identified in a patient. Decentralized apps retain the list of contacts on the phone itself. whereas centralized apps store those data on a central server (Zastrow 2020).

In Finland and the European Union, studies on the performance of Koronavilkku and comparable applications were conducted. The findings indicated that Koronavilkku was effective in curbing the pandemic, and at its peak, it had 2.5 million users. In relation to the size of the Finnish population, Koronavilkku is among the most widely used COVID-19 tracking applications worldwide. 64,000 individuals in total used the app to report illnesses. Users of Koronavilkku said that 23% of them were informed of possible exposure (Moiso et al., 2020).

The main goal of Koronavilkku is to keep track of all communications between parties while minimizing any potential threats to the privacy of sensitive data. Its properties are based on Bluetooth's proximity sensing and broadcast functions, with the broadcast function's RSSI value serving as the major determinate. However, the contact history tracking technique used by Koronavilkku contact tracing software does not perform positioning or transfer of positioning information, in addition to not revealing the other party's name. This mitigates worries about data security and personal privacy. To accomplish the goal of the contact tracing app, the contact history surveillance technology utilizes a device with Bluetooth technology as either a transport mechanism based on the presence detection feature and data transmitting in low energy Bluetooth or by the description of a data exchange mechanism. The Bluetooth label will automatically adjust every 15 minutes, lowering the privacy risk of personal identification (Rannikko et al. 2022).

The data gathering for the Koronavilkku app is split into two categories: agreed return data and automated broadcast data. The automatic live stream data is broadcast to other nearby device users as contact tracing, as a documentation that the two parties have been in contact at a specific distance, but neither one of them will know the detailed information, and neither will the program developer who exchanged the contact data. Only the data is left on the device. Below are some issues that have been highlighted. The reporting mechanism advocated by the health organization must be used to actively report data. The public health system's cloud platform will get the encrypted files of the verified person with the confirmed person's agreement so that the cloud platform can alert the reporting of the verified COVID - 19 pneumonia. Other users who have had communication with COVID - 19 pneumonia patients can find out the details of that interaction from the device side, but users who have had contact with verified patients are still unable to find out the specifics of that contact, including the day and time.

The goal of the Koronavilkku contact tracing app is to keep a record of all a party's contacts while minimizing any potential risks to the privacy of that information. The function's primary body is the RSSI value. However, the Koronavilkku contact tracing history tracking technology does not conduct location or the transmission of positioning information, nor does it perform or contain the name of the other party. This eliminates worries regarding information security and personal privacy (Taipale at al. 2022). Users of the Koronavilkku contact history tracking system, which is based on Bluetooth broadcast and proximity detection features, will only be able to answer the question "yes" or "no" as to whether they have interacted with patients, but they won't be able to answer the questions "when," "where," or "with whom." Additionally, citizens won't be able to identify patients who have been diagnosed with COVID-19 pneumonia because of the system's design, which aims to prevent panic

THL made a formal announcement on the end of Koronavilkku on June 1st, 2022. The justification offered is that given the present pandemic scenario, using Koronavilkku is no longer appropriate. In many areas, large-scale examination has been ignored in favor of focusing on a small number of select individuals, such as medical professionals and high-risk populations. Giving up official detection entails ceasing to generate essential code in bulk for app infection notifications. Since there is no need to utilize Koronavilkku during the present outbreak, it is closed. In a large portion of the nation, the necessary conditions for mass testing are no longer present, which means that the essential code required to report illnesses to use the application is no longer needed. The goal is to regulate app shutdowns when the efficacy declines under new pandemic circumstances. No longer is Koronavilkku used to calculate possible exposures, monitor exposure data, or report illnesses. However, according to THL, the technology employed in the app can be utilized again in the future to control potential outbreaks, given that national epidemic surveillance applications can use the Exposure Notification (EN) interface supplied by Apple, Google, and Huawei (THL, 2022).

3 PURPOSE AND OBJECTIVE

This study’s goal is to assess and analyse the Finland’s digital health tool - Koronavilkku, that has been used to reduce the impact of the COVID-19 pandemic. Since it first emerged in December 2019, COVID-19 has spread rapidly in more than 180 countries around the world, with the death toll surpassing 700,000 in just a few months. As of this study, many countries have managed to control it.

Proponents claim that the contact tracing application is a commonly used and successful method for keeping tabs on and curbing the coronavirus's spread. An infectious disease prevention method called contact tracing apps seeks to locate persons who may have had contact with an affected person. The employment of this technique in previous pandemics, such as SARS in 2003 and H1N1 in 2009, demonstrates that it is not new (Ferretti et, al 2020). This study's research queries include the following:

- How well did Finland’s Koronavilkku support the clinical and practical steps taken to manage and ultimately control the COVID-19 pandemic?

- How efficiently have the practical and clinical procedures for Koronavilkku been managed and controlled during the COVID-19 pandemic?

4 METHODOLGY

4.1 Narrative literature review

As thorough familiarity with the relevant literature is required to begin research, this is a necessary component of an academic research project. It seeks to examine the present situation and important issues in a certain field of interest and offer a strong foundation for ongoing research, especially with the ever-increasing volume of articles published. The COVID - 19 pandemic and research into digital contact tracking applications with an emphasis on Finland's "Koronavilkku" will be examined in this literature review. Research on theoretical frameworks is used to determine which kind of the frameworks used in the plan will work best for this project. This works begins by starting to construct them employing the entire architecture, then includes them into my thesis' simulation work. This will begin concurrently with the literature review.

4.2 Literature research process

Data collection – Inclusion and Exclusion criteria

The research sources are reliably, consistently, evenly, and impartially identified by the inclusion criteria. The population that was chosen for the study is identified by the exclusion criteria's components or features. These factors might act as confounders and skew the outcome parameter (Indian, 2016, 640-645).

Inclusion criteria	**Exclusion criteria**
The study or article has been published between 2020-2022	The study or article was published before 2019
English literature	Non-English literature
Free literature	Paid literature
The title or abstract contains at least one of the following keywords: Digital Health tools, Koronavirlkku, Coronavirus tracing apps, COVID–19 Pandemic control, Review	The title or abstract does not include any of the following keywords: Digital Health tools, Koronavirlkku, Coronavirus tracing apps, COVID–19 Pandemic control, Review

Table 1 Inclusion and exclusion criteria for data collection

Study and article selection process

The last search of the Scholar Google, Science Direct, PubMed and EBSCO database was made in August 2022. The Koronavilkku, COVID – 19 contact tracing apps, COVID–19 pandemic control, Review was used as keywords

Database	Results with limiters	Included by title and abstract	Included by full text
Scholar Google	91	7	2
Science Direct	5	3	2
Pubmed	19	9	2
EBSCOhost	267	11	1

Table 2 Study and article selection process

Timeline and resources

I am conscious that this research methodology has certain limitations. First, a variety of methodological and clinically varied research were found in the literature search. The methodological differences across the research may have affected the outcomes, skewed my findings, and constrained my interpretations. Since I only used papers from peer-reviewed English-language publications, the research may have been constrained and the data may have been skewed leading to overly narrow conclusions.

Types	Description	Purposes
Material Wang et al. 2022 Taipale et al. 2022	Theory base	Narrative literature review, identifying the general theory of digital health tools prevent COVID – 19 pandemic prevalence
Material Zetterholm et al. 2021	Framework	Theoretical frameworks research, specific research framework focus on my study
Material Shubina et al. 2021	Maps of area	Identifying and specific areas of the research
Material Garousi et al. 2022 Rannikko et al. 2022	Data analysis, and reporting	Reviewing the articles, compiling statistics and other relevant information about the characteristic of digital health tools prevent COVID – 19 pandemic prevalence

Resources PubMed, Scholar Google, Science Direct, EBSCOhost	Data extraction	Reputable journals, books, different articles, websites, and other sources were considered on the digital health sectors.
Resource WHO, THL, GDPR	Organization supporting	Obtained from the existing statistical data, policies, regulations, and standards were considered for the review.

Table 3 Research materials and resources

A responsible research attitude includes searching the literature as thoroughly as feasible. The materials that author gathered from books, materials, and resources are complete. A thorough and substantial amount of literature is required for creating a decent research narrative literature review. The representativeness, dependability, and scientific quality of the literature research have all been considered. Because the author's comments and analysis are included in the literature review, it is vital to distinguish between the author's perspective and the content of the literature (Green et al. 2006, 101 -117).

Materials from 7 scientific studies were collected for this study, which detailed the conceptual theory base, framework, maps of areas, data analysis, and reporting. The narrative literature review was intended to identify the general theory of digital health tools to prevent COVID - 19 pandemic prevalence, theoretical frameworks research, particular research framework emphasis on this study, identifying and specific areas of research. Furthermore, reviewing the articles, compiling statistics and other relevant information about the characteristic of digital health tools prevent COVID – 19 pandemic prevalence.

The resources were gathered from PUBMED, EBSCO (CINAHL), SCIENCE DIRECT, and GOOGLE SCHOLAR, as well as WHO (World Health Organization), GDPR (General Data Protection Regulation), and THL (Finnish Institute for Health and Welfare), which described data extraction and organisation support. The evaluation obtained from the existing statistical data, policies, regulations, and standards were considered for the review. On the digital health sectors, credible journals, books, various articles, websites, and other sources were evaluated.

Whatever review technique is used, the gathered literatures were summarised, compiled, and evaluated, and the historical context, current status, and development direction of the review specified in the methodology section were explained. In this study, pay close attention to the citations and reviews of representative, scientific, and creative literature. (Creswell, 2014, 40 – 41)

Preliminary timetable

The prediction of final thesis time schedule will length 9 months, March 2022 – December 2022.

Phases	Schedule
Planning Phase: ▪ Thesis topic plan ▪ Thesis work plan	 ▪ February 2022 ▪ April 2022
Phase of Implementation: ▪ Narrative literature search ▪ Selection of Primary studies ▪ Extracting, evaluating, and reporting data	 ▪ April - May 2022 ▪ May – June 2022 ▪ September 2022 – December 2022
Presentation Phase ▪ Thesis submission	 ▪ December 2022

Table 4 Preliminary thesis schedule

4.3 Data analysis

Content data analysis is a research technique for objective, methodical, and quantitatively describing dissemination research results and content. To determine the specific meaning from the meaningful words and phrases used, it is essential to analyse the quantity of information included in the disseminated material and how it evolves over time. Layer-by-layer reasoning is used in the process of content analysis (Bryman, 2011) Five components make up "content data analysis": data management, chunking of text, coding of chunked, analysis of coding, and thesis. These five factors are essential and significant parts of the narrative literature review research questions and the research questions for the COVID-19 contact tracking app.

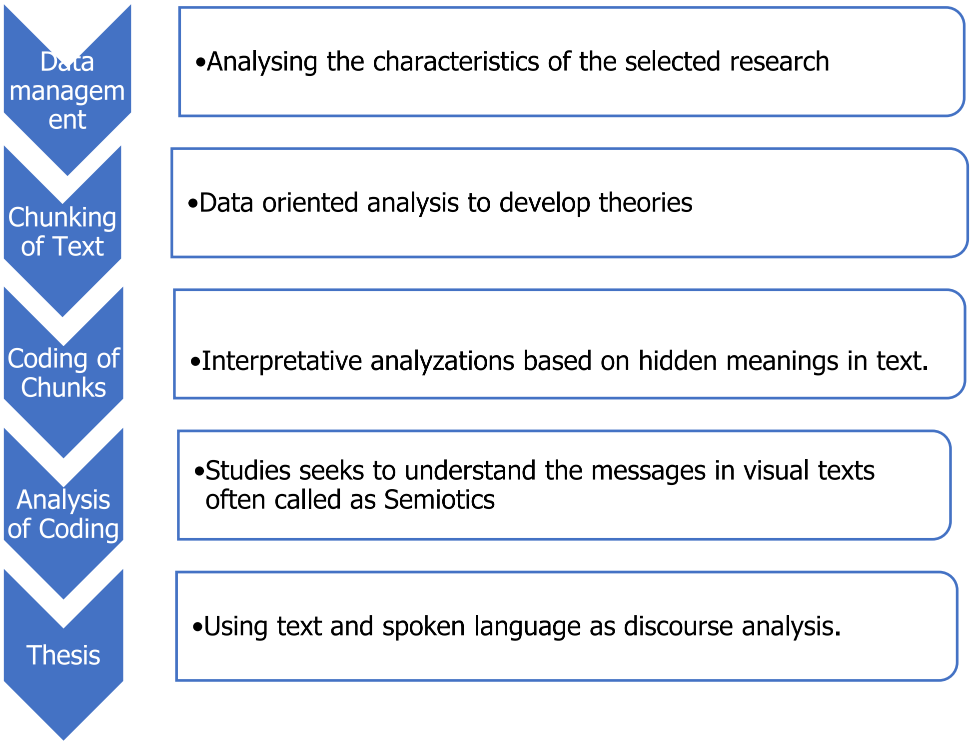

Table 5 Content data analysis form for data management

Flattening the curve for COVID – 19

In the 2019 coronavirus pneumonia infection illness epidemic, flattening the curve mostly serves to limit the transmission of SARS-CoV-2. This terminology was adapted from the US Centers for Disease Control and Prevention's public health strategy (CDC, 2007). The epidemic curve is a graphical representation of the number of epidemic cases reported by the illness beginning date and can offer thorough details about the outbreak, including transmission routes, outbreak magnitude, atypical cases, trends over time, and times when exposure and disease incubation last (LaMorte, 2018). The pathogen, route of transmission, duration of each generation, type, and length of exposure, as well as the length of the incubation period and the number of susceptible people exposed, all affect how the epidemic curve looks. The link between the total number of cases and the passage of time is represented by the infectious illness curve. The time axis is on the X-axis and the number of instances is on the Y-axis. On the other hand, if the emergence of new cases can be slowed down through successful epidemic prevention measures, the infectious disease curve will be flattened (Feng et al. 2020).

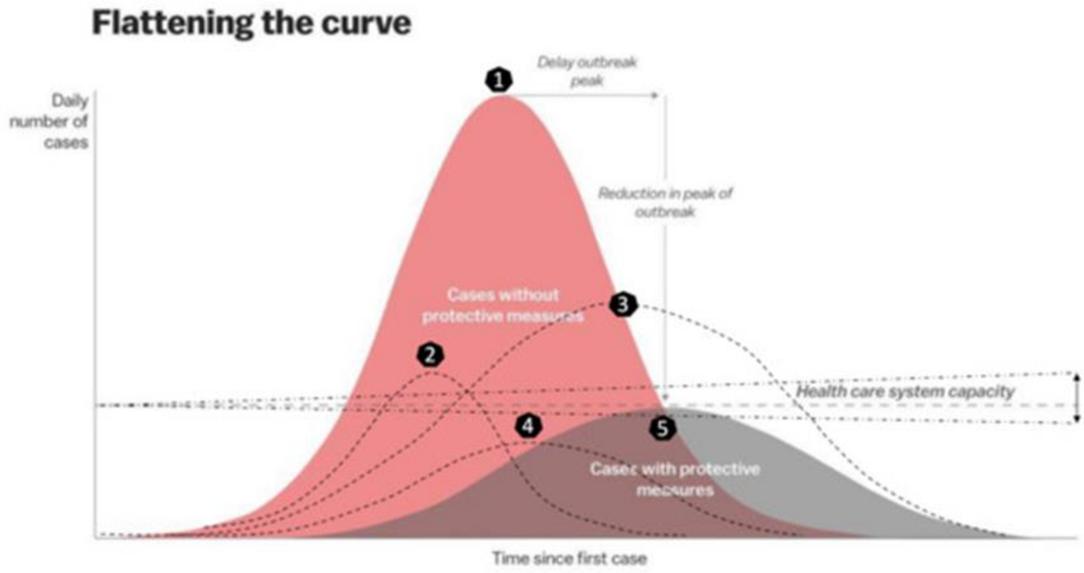

Figure 4. A static representation of infection trajectories (Tom et al. 2021)

The graph above represents the epidemic curve, which graphically depicts the progression in the number of infected individuals needing medical attention. When there are more illnesses than the healthcare system can handle during the COVID-19 pandemic, the system collapses. The term "flattening the curve" refers to taking various steps in the early stages of COVID - 19 epidemic to postpone the onset of the epidemic's peak period and attempt to prevent concentrated outbreaks, thereby lowering the peak number of patients who require treatment at any given time and preventing overload or even the collapse of the medical system (Van der Voorn et al. 2021). Precautions like handwashing, social distance, isolation, and disinfection have decreased daily infections, flattening the epidemic curve. Other precautions like isolation depend on these steps for disease control to work. Successful curve flattening would stretch peak hospitalizations below the line of medical service capacity over time and increase medical intervention potential (Shaban et al. 2020). Resources won't run out or be in short supply if this is done, whether they be human or material. To prevent nosocomial transmission among medical personnel working in hospitals, it's crucial to follow the proper safety precautions and protocols as well as to keep exposed staff and patients isolated from the public (Feng et al. 2021).

In Shubina's research article, she points out that since the start of the COVID-19 global epidemics, digital contact tracing applications have come into the spotlight as a digital tool to help citizens monitor their social distance, which appears to be one of the most effective methods for preventing the spread of air - borne infectious diseases (Shubina et, al. 2021). To detect the physical distance between residents and notify individuals when contact with an infected person has occurred, many nations have been attempting to build acceptable digital contact-tracing apps. Digital contact-tracing app uptake, however, has thus far been hindered by issues with mobile device compatibility and user privacy concerns. A trade-off must be made between the technical performance that may be expected from technological advances, false-positive frequencies, and behavioural and social aspects. As a result, Shubian et al. concluded that contemporary upcoming mobile system infrastructures, including 6G, smart cities, including intelligent transportation systems, should standardise a pandemic contact-tracing mode. Their research article aims to present a combined model, which is completed by analysing multidimensionality to achieve the best results in accordance with the "flattening the curve" strategy. Contact tracking applications are divided into three categories: Technical, Social, and Epidemiological, in this order. This is done to supplement the existing research discussed previous section and to identify the epidemiological, social, and technical perspectives jointly (Shubina et, al. 2021).

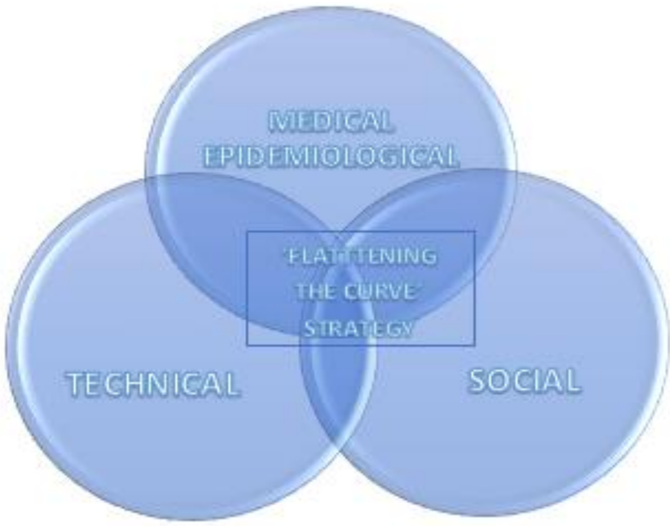

Figure 5 Measures in the fields of technology, society, and epidemiology are needed to flatten the COVID-19 curve (Shubina et, al. 2022)

Once COVID-19 was widespread, "flatten the curve" was a term frequently used, which meant to low-er the peaks on the graph and flatten the curve of the COVID - 19 epidemic, thereby reducing the infection rate. A complementary measure is to raise the level of medical care or "raise the line" by im-proving the hospital system's ability to treat large numbers of patients. Increasing the amount of health care available can avoid medical overload due to shortages. Technological, social, and epidemiological interventions have been used to reduce daily infections, thereby flattening the epidemic curve. A successful flattening of the curve would limit medical demand over time and spread peak hospitalizations below the medical service capacity line. So, no matter whether it is material or human, re-sources will not be exhausted and lacking. It is important for health care staff in hospitals to use both appropriate protective equipment and procedures, to separate infected patients and exposed staff from the rest of the population, and to avoid nosocomial transmission. Efforts to flatten the curve need to be accompanied by efforts of raise the line, to increase the capacity of the healthcare system. Healthcare capacity can be improved by equipment, medical staff, providing eHealth, mHealth, home care, and health education to the citizens. The purpose of raising the line is to provide adequate medical equipment and supplies to more patients (Shubina et.al, 2022).

The following results were drawn after comprehensively analysing 7 articles in detail data and synthesising the five elements of data management, chunking of text, coding of chunked, analysis of coding, and thesis in "content data analysis" and the theory of "flattening the curve" in the management and prevention of the COVID-19 epidemic.

TITLE	TECHNICAL	SOCIAL	EPIDEMILLOGICAL
What Users Think of COVID-19 Contact-Tracing Apps: An Analysis of Eight Euro pean Apps	Centralized or decentralized, Privacy, and a lack of comprehension of individuals' technical surroundings	Lack of citizen involvement, without cultural considerations, Average number of stars in Koronavilkku 3,3 – 3,4	Effectiveness concerns
Population-Based Assessment of Contact Tracing Operations for Coronavirus Disease 2019 in Pirkanmaa Hospital District, Finland	Efficiency, effectiveness, transmission settings. Digitalized process. Technical operations need reconsideration after the Omicron wave began	Social constraints. The most frequent place for transmission was a household, and before testing, 50% of COVID-positive high-risk contacts were quarantined.	2020 May, National strategy - test, trace, isolate and treat
Digital contact tracing applications during COVID-19	Technology acceptance, app adoption, access to technology, advantages as viewed, privacy concerns	Public attitudes, trust, understanding, social responsibility,	Perceived health threat, the intention – action gap, health technologies
Effectiveness modelling of digital contact-tracing solutions for tackling the COVID-19 pandemic	The interoperability of mobile devices, privacy concerns, achievable technical performance,	Usability and user experience, likelihood of user adoption, and privacy concerns all have a direct and indirect	false-positive rates, infection risk, costs

	mobile devices, reliability	impact on the user adoption rate.	
Integrating Digital Technologies and Public Health to Fight Covid-19 Pandemic: Key Technologies, Applications, Challenges and Outlook of Digital Healthcare	Data latency, data fragmentation, privacy security, and data security risks are all related to big data, artificial intelligence, cloud computing, and 5G.	Early detection of probable patients, a lockdown of the region, and the stopping of further epidemic spread	Pandemic prevention and control, tracking, remote monitoring, telemedicine, knowledge training, drug, and vaccine development
Adoption of a COVID-19 Contact Tracing App Among Older Internet Users in Finland	Internet, online symptom checker, smartphone, digitization	Older adults, socioeconomic, survey	Exposure, tracing, satisfaction with health, epidemics
Mining user reviews of COVID contact-tracing apps: An exploratory analysis of nine European apps	Digital epidemiological surveillance, effectiveness, software quality, data mining,	Public adoption, communication, language, population, user experience, public perception	Case identification, Interruption of transmission, clinical care

Table 6 Data analysis of technical, social, and epidemiological in digital contact tracing applications

5 RESULTS AND NARRATIVE LITERATURE RESEARCH

5.1 Evaluation of the Results

Evidence-Based recommendations for using simulated outcomes to effectively support actual results. The following evaluation is based on the results of the narrative literature review and clarifies and supports the implications for the research questions. According to the narrative literature evaluation, the study questions were as follows: What are the clinical procedures to be followed when using Koronavilkku for COVID - 19 pandemic control? These processes are connected to the technological, social, and epidemiological aspects. Narrative literature review is the research methodology in this study. By utilizing Savonia - Finna to search a database, seven publications pertaining to my field of study were located: EBSCOhost, Science Direct, Google Scholar and Pubmed.

Technological	Availability, Reliability, Accuracy, Privacy, Beneficence, Accessibility, Technical approaches, Legal principles, Centralized or decentralized.
Social	Voluntary participation, User privacy, Communication skills, Community, Language proficiency, Context and culture, Cost of participation, Economic
Epidemiological	Monitoring, Surveillance, Supporting provision, Vaccination, Pharmacovigilance, National strategy

Table 7 Factors affecting the use and efficacy of COVID-19 contact tracing apps

The data analysis gained from the academic articles focused on several technological elements selected through the literature review: availability, reliability, accuracy, privacy, beneficence, accessibility, technical approaches, legal principles, centralized or decentralized. Social factors were identified and classified and include voluntary participation, user privacy, communication skills, community, language proficiency, context and culture, cost of participation elements, and economic issues. From the epidemiological factors several elements were based on academic articles selected during the narrative literature search. The elements identified are classified as monitoring, surveillance, supporting provision, vaccination, pharmacovigilance, and national strategy. Those elements will be described in more detail below.

5.2 Technological

The narrative literature assessment found several components that demonstrated the technological sophistication of the COVID - 19 contact tracing programs. Since the COVID - 19 epidemic broke out in 2020, some nations have introduced contact monitoring programs based on communications and personal data to swiftly locate close connections of confirmed sufferers. These different contact tracing programs utilized a range of electronic communication tools, including Wi-Fi, Bluetooth, GPS, QR codes, etc. boosting the efficiency of contact tracing software (Wang et al. 2021). Bluetooth technology is used by contact tracking applications to keep track of who users have been in close contact over the last 14 days. The user must provide their cell phone number and enable Bluetooth before using it. The tracing app will now automatically find any nearby users within a range of 2 to 5 meters. The applications will start recording each other's data after 30 minutes of communication. Digital contact tracing applications extends traditional epidemiological manual tracking by adding additional information and new sources of information, including tracking apps, GPS geolocation and mobile data etc. (Garousi et al., 2022). Healthcare authorities may utilize the mobile app to track down everyone who may have meet an infected individual once the sick person has been identified. Exchange of personal health data can assist in avoiding COVID-19 exposure (Garousi et al, 2022). Using a mobile app, individuals at high risk of contracting COVID-19 can be successfully tracked. Immediately upon case confirmation, the software can track down contacts and notifying them. It can instantly notify nearby contacts of freshly verified cases by momentarily collecting proximity events between people (Zetterholm et al. 2021). Contact tracing applications must get users' express agreement to process sensitive personal data under the most stringent General Data Protection Regulation (GDPR), whose usage is severely limited. Users must voluntarily use contact tracing apps.

In various common service scenarios for epidemic prevention and control, such as material allocation, intelligent diagnosis and treatment of epidemic illnesses, and medication research and development, digital technologies like AI, 5G, and big data have arisen. The COVID-19 outbreak is controlled and contained using these methodologies. It was crucial in increasing the effectiveness of control work. Numerous important aspects must be considered, such as patient adherence, high-quality evidence, worker training, and digital equity (Zetterholm et al. 2021).

The COVID-19 epidemic has had a significant impact on most nations, increasing both the demand for digital health services and the number of healthcare professionals online medical consulting services. Digital health services have now become an important part of the daily work of hospitals and clinics (Wang et al. 2021). During the COVID - 19 epidemic, in principle, many people tried to go to the hospital as little as possible and preferred to contact doctors by phone and the Internet and use telemedicine for treatment advice.

Reliability must take data privacy, data protection, and ethics into account at all phases of contact tracing application operations, including training and use of technical solutions (Rannikko et al. 2022). The legislative framework of the nation where the system is implemented must be taken into consideration while developing measures to ensure privacy and data protection. Before usage, digital technological instruments for contact tracing applications should be evaluated to guarantee data protection in accordance with local laws. As early as the 1990s, Finland began to create legislation to safeguard residents' privacy and personal information. The Personal Data Act oversees the acquisition, storage, and utilization of personal data as general law. This increased Finnish people's trust in the government. During the COVID-19 outbreak, Finns are more inclined to willingly utilize Koronavilkku (Dla Piper, 2022)

Staff members who work with contact tracing programs must adhere to ethical standards to ensure ethical data processing and respect for privacy throughout the process. It is necessary to convey to everyone involved in the process in a clear and transparent way how data is processed, stored, and used. This is crucial for identification, engagement, and to prevent misconceptions that can compromise the efficacy of programs using contact tracing software (Garousi et al. 2022).

Where access to reliable technology is limited, such as in low-income settings or among the elderly, COVID - 19 contact tracing applications can be problematic, and this can negatively impact their effectiveness. Aside from data privacy and security, other big issues include coverage, having a smartphone, voluntarily downloading apps, and voluntarily uploading a personal identity code. Each step filters out a subset of the population, such as the elderly, those living in rural areas, and low-income groups. Contact tracing application downloads in poor countries are significantly lower than in developed countries. Taipale et al. point out that due to the well-established social welfare system in Finland, the elderly and vulnerable groups were not affected in the process of downloading and using the Koronavilkku contact tracing application in Finland (Taipale et al., 2022)

COVID - 19 contact tracing application system access issues, including narrow network coverage, insufficient data, technical issues, and increased staff training needs are all important issues that affect the efficacy of this technology. Personal spending on contact tracing app has increased due to travel and charging smartphone batteries (Garousi et al. 2022). Traditional interview-based contact tracing relies heavily on the presence of a trained workforce to carry out basic activities such as contact information acquisition, notification, and follow-up. The workers might, however, easily become overworked in a situation like the rampant COVID-19 outbreak. Digital technology is likely to be the best method of contact tracing during the Covid-19 outbreak, or future pandemics. They should be combined with other more traditional techniques to stop the COVID-19 infection from spreading (Garousi et al, 2022). It must be noted that digital technical tools are not a substitute for trained health care professionals, qualified supervisors, decentralized operations and good coordination, all necessary compliments for successful and effective contact tracing application (Rinnikko et al, 2022).

Digital tools and information technology, which have been used to improve the accuracy of contact tracing efforts have been used during the COVID-19 pandemic. But so far, no single digital tool can address all the steps required to monitor end-to-end contact tracing and contact isolation. Supervision by health care staffs is still required. When deciding to use these digital tools, the technical and ethical requirements associated with the use of their digital tools should be considered (Shubina et al. 2021)

Digital tools to support contact tracing efforts can be broadly grouped into three categories, technical, social, and epidemiological. Based on their public health function in specific steps of contact tracing efforts, Identify and notify contacts, these solutions are designed for use by the citizens, health professionals and contact tracing teams. These consist of digital proximity tracking tools, which notify users if they have been in constant close contact with individuals whose COVID-19 testing results have been logged with the tool. These tools rely on a system based on Bluetooth or GPS location signals. There are also location-based digital contact tracing tools that use a quick-response code that smartphone users can scan when they go to a venue, so that if they later test positive for COVID-19, they can find other tracing app users who have been to the same venue at the same time may be alerted if health authorities deem it necessary. The digital tools are intended for use by individuals identified as contacts, health care professionals, and contact tracing teams and include symptom-checking tools that can help contacts self-monitor and report the presence or absence of symptoms to health care professionals who can conduct further assessments, provide health care counselling, and put them in touch with public health authorities for Inspection and access to other support services. These techniques are especially helpful in circumstances when the contact tracing team's workforce is constrained and there is physical or security constraints impeding on-site inspections. Using surveillance data management and analysis, health care professionals use these solutions to collect, manage, analyses, and present data collected by contact tracing teams that link cases to contacts. These comprise epidemic response instruments that may be used for case investigation, contact tracking, and analysis (Garousi et at, 2022, Wang et al 2021).

5.3 Social

The development and popular acceptance of COVID - 19 contact tracking apps are influenced by social variables including peoples' willingness to participate voluntarily, privacy concerns, communication, community solidarity, social context and culture, as well as economic considerations. One of the characteristics of modern global emergencies is that they have more complexity, variability, and derivation. Coronavirus pneumonia caused a public health crisis, a unique health and safety risk from its beginning. In the process of epidemic development and response, a variety of related social phenomenon have been highlighted, such as human rights, community solidarity, culture and context, social stability, and economic security. Many studies have shown that citizens, especially elderly and other uniquely vulnerable groups like the poor, or marginalized immigrant populations, are the hardest hit by the COVID - 19 epidemic. They are the most vulnerable populations, whether from the standpoint of health protection or from the perspective of job, income, everyday living, etc. The fact is that people from different socioeconomic classes have varying tolerances and ability to cope with a calamity like the COVID-19 pandemic. In the face of enormous disasters and large hazards, it appears that humans are not equally resilient. Especially after being infected by the coronavirus, personal and family medical security conditions may be particularly difficult, and ability to obtain government and social support is in some contexts relatively weak. At the beginning of the COVID - 19 epidemic, these less privileged populations were often the ones who travelled between various medical institutions, and many experienced isolation and helplessness.

Finding those who have come into the contact with an infected person, properly and effectively notifying them, and advising users who have close contacts to self-isolate or alert them to risks so that medical attention can be sought when necessary are all ways to stop the COVID-19 epidemic from spreading. If it were done manually, it would take a lot of labor. Technology companies have developed COVID-19 contact tracing tools to help with contact tracing and provide an interoperable digital platform for real-time study of the COVID-19 Epidemic. However, many people are concerned about the effectiveness of these applications and the impact on privacy. Because public or private institutions will share a large amount of personal information and traces, leading to risk of personal data leakage. Considering the COVID-19 epidemic, Europe has always put respect for human rights first and has also been very careful about such tracing needs (Shubina et al. 2022)

Two rival application strategies, centralized contact tracing and decentralized contact tracing, are at the center of the COVID-19 contact tracking program's privacy issue. Centralized contact tracing was originally the main application of the European COVID - 19 epidemic tracking plan, but now faces two major controversies. The first controversy is whether the data information collected by the application is centrally stored in the backend database or stored in a decentralized manner. The second controversy is whether the development of the program is transparent enough. Public health organizations must take part for the decentralized "Bluetooth contact tracing" technology that Apple and Google have jointly supported. This approach is more decentralized and stresses that users sign up willingly and that their identities, whereabouts, and other personal information are not collected. Personal data is immediately kept and matched locally for the users, negating the requirement for centralized user data.

The Finnish COVID - 19 contact tracking application ''Koronavilkku'' utilized the decentralized contact tracing method to manage users' personal data information. With Bluetooth tools, smartphones automatically exchange and store identifiers when users are within reach of a Bluetooth signal. The attempt to strike a compromise between the preservation of individual privacy and the implementation of the epidemic early warning function involves collecting Bluetooth-based contact information rather than individual real-time location information. It is still valuable to take note of the privacy and data security industries' cautious mentality. The Bluetooth contact tracing program dilutes works around identity and location issues and privacy concerns by focusing only on the time and distance between a specific pair of users, and most user data is merely encrypted and saved locally, with the user as the center, to realize the epidemic warning to the user (Shubina et al. 2021, Garousi et al. 2022)

Although COVID - 19 contact tracing programs are useful for locating the contacts of coronavirus outbreaks, individuals are concerned about how to safeguard their privacy and data security. There are important questions that may be used to analyze privacy risks, and what is an acceptable invasion of privacy? The amount of privacy invasion may be higher in a centralized contact tracking system than in a decentralized one. After all, in addition to perhaps identifying persons internally, a centralized system may combine smartphone contact monitoring data with other accessible data, such as location data, clinical data, other user information, or available in other datasets. A centralized system may integrate smartphone contact monitoring data with other accessible data, such as location data, clinical data, other information about the user, or available in other datasets, in addition to possibly identifying people internally.

A centralized authority may therefore be able to comprehend the movements and interactions of smartphone users' social network thanks to a centralized contact tracking system. The amount of interruption in a decentralized contact tracking system is probably rather low. It doesn't provide health authorities or other government agencies the power to create a social network of connections for smartphone users on its own, as information is not disclosed to anyone other than the individual user on the smartphone, other than to publish anonymous information (Gerousi et al. 2022, Zetterholm et al 2021)

Article 8 of the European Declaration of Human Rights states that everyone has the right to "Respect for his private and family life, his home and his communications" (ECHR). It provides a clear legal foundation and provides guidance on how this right should be protected even during efforts to control and detect contagious illnesses. User permission and sufficient legal safeguards against arbitrary decision-making are key. People must understand how a contact tracking program works and tracks their behavior. The processing of data involved, including any discretionary method that it is utilized, should be transparent and justified, and the action on this should be consistent with the strict standards and requirements in the GDPR (ECHR 2022, GDPR 2016).

Contact tracing applications should emphasize necessity and proportionality. For example, the objectives of the measures taken must be important enough to justify restrictions on a fundamental right. In this regard, data minimization principles are largely implemented through decentralized contact tracing technologies, including data anonymization and pseudonymization. These are expressions of the decentralized contact tracing system's emphasis on preserving the data subject's rights, including processing personal data on the device to prevent unauthorized access to data, deleting pertinent data after 14 days, and the requirement for specific agreement. Article 4 of the GDPR states that anonymous information is excluded from the definition of personal data and that to be anonymous "Any information directly or indirectly connected to an identified or identifiable natural person must not be collected or stored" (Art. 4 GDPR, 2020). It is noted that the analysis of location data may be utilized to adequately break the epidemic's coronavirus infection chain. The privacy protection design of decentralized contact tracking technology also reflects its primary practical features. The temporary Bluetooth identifier it uses in place of location and device identification is not conventional, normal personal data. (GDPR, 2016)

The Covid-19 pandemic has destroyed the global economy more than the global financial crisis of 2008 did. According to the World Economic Outlook report released by the International Monetary Fund (IMF) in October 2020, the world economy was expected to shrink by 4.4% in 2020. In 2020, the IMF forecasted that per capita income of more than 95% of countries would decrease. China will be the only nation among the world's major economies to continue growth, according to the most recent IMF prediction. In the meanwhile, growth in the Chinese economy is anticipated to continue in 2021. (IMF, 2020). The "Worldwide Economic Outlook" for 2022 issues a warning that tightening is beginning to bite and that a global economic recession is likely to result from persistently rising inflation and more aggressive monetary policy tightening (McKeown, 2022). The world economy is predicted to grow by just 1.7% in global GDP in 2023 because of the widespread doom. This would be the weakest rate of world economic growth in forty years. In addition to the incredibly low base that the global economic crisis in 2020 generated, there are other favorable factors that will raise the pace of global economic growth in 2021. Efforts to avert a recession and financial turbulence are stabilizing strategies and will continue to be successful (WB, 2020). The globe was undergoing a fresh wave of economic change and technological revolution prior to the COVID-19 pandemic. Modern information technologies like the Internet, big data, and artificial intelligence were progressing steadily as the digital economy grows. Big Data, artificial intelligence, cloud computing, and other technologies have had a significant impact on COVID-19 epidemic resource allocation, including viral tracing, prevention and treatment, and epidemic monitoring and analysis. Digital business models and innovation will help the industrial sector expand more digitally, networked, and intelligently. The COVID-19 outbreak will hasten the adoption of new information technology and iterative upgrades tailored to user demands, and it will hasten the growth of the digital economy relative to pre-epidemic levels. The global economy's sustainable economic development is being driven by the digital economy (Wang et al, 2021)

Since 2020, the Finnish government formulated and implemented a COVID - 19 epidemic prevention policy based on its own national conditions and has continually modified the preventative and corrective procedures in accordance with its timetable and environment. Its purpose is to maximize the life and health of citizens and at the same time, ensure the continued health and stability of the economy and society with good prevention, development, and control efforts. The Finnish government was confident that it would prevail in the difficult fight against the COVID-19 outbreak. Since the outbreak of the coronavirus pneumonia, Finland has successfully controlled the epidemic, restored social order, resumed work and production, and achieved positive economic growth. The stable epidemic prevention and control situation provides a favorable environment for Finland to maintain a leading position in world economic development and epidemic prevention and control (Taipale et al. 2022).

The problem of COVID-19 contact tracking application mutual recognition is the result of the variations in national epidemic prevention strategies among EU nations. Due to the different characteristics of the populations, locations, and other factors on the spread of the epidemic in different regions, there are also differences in the means of epidemic prevention and control. In addition, governments understand and implement the COVID - 19 epidemic differently, and these differences also lead to differences in countries' epidemic prevention policies. Although multiple nations' health information data were critical in the prevention and management of the pandemic, certain issues such as non-sharing and mutual recognition between areas, delayed data exchange, and inadequate oversight were revealed throughout the process. The "European COVID - 19 Data Platform" was introduced by the European Commission on April 20, 2020, to give researchers an open digital platform for Europe and the rest of the world to quickly gather, store, and share research data like the genetic sequence, protein structure, related research data, and research articles for the COVID – 19 epidemic (LOBO, 2020).

Several European firms and institutions collaborated to create the European COVID - 19 Data Platform. COVID - 19 contact tracing software, big data, and AI components are now available to governments throughout the world. The backend of the European COVID-19 Data Platform is based on a highly scalable technology that is already in use by some of Europe's leading financial institutions. The platform is open source. It was designed to help with testing coordination in healthcare institutions by allowing users at high risk of infection to book testing sites directly from the app. The burden will be reduced, and the medical testing procedure will be more efficient. With the use of Bluetooth contact information and location information, the European COVID-19 Data

Platform achieved a high level of validity. The remedy was created in accordance with EU data privacy laws (Cochrane, 2020)

Although the COVID - 19 contact tracing application data information from various countries was critical in the fight against the epidemic's spread and containment, issues such as non-sharing and mutual recognition between regions, delayed data exchange, and weak supervision were revealed during the application process. Some of commentators believe that in order to achieve more scientific and precise epidemic prevention and control, the mutual recognition of global health data information cannot wait (Garousi et al. 2022, Shubina et al, 2022).

5.4 Epidemiological

Monitoring and surveillance during the COVID – 19 epidemic

At the height of the COVID-19 epidemic, many nations had established their own contact tracking tools to keep track of patients and restrict the spread of the coronavirus. It's critical to understand how these programs and technologies work, as well as how governments use them to monitor and follow users on users, track the spread of the coronavirus, and track individuals' movements.

The strength of indicator-based surveillance is a function of frequent, strong, and trustworthy surveillance reports, which may reach a larger population (Rannikko et al.2022). Traditionally, contact tracing has been performed by trained public health professionals who interview patients, ask about everyone they have been in contact with recently, and then contact those people and provide them with the help and support they need. All these operations are based on protecting the privacy of patient identities. However, in relation to the Covid-19 pandemic, this careful approach to inquiry is no longer feasible, necessitating the use of more automated techniques. Using digital technology, coronavirus diagnoses are sent to a central server, allowing healthcare officials to quarantine those affected while protecting the infected person's anonymity (Wang et al. 2021).

New digital technologies like contact tracing apps allow remote monitoring of users' physical condition and discover potential sources of infection (Wang et al. 2021) Combining applications and data on a smartphone may establish who the phone owner has contacted or been in communication with at a certain moment, and this data can be used to track and inform everyone who has been in contact with someone who has COVID-19.

Bluetooth-based contact tracking apps can be paired with data collection apps that differ from traditional tracking apps because their goal is to identify individuals and track their movements. (Garousi et al. 2021). Users may link their identification to their device, assist authorized medical personnel in understanding the spread of the virus, monitor who needs to be tested, and rapidly contact sufferers. (Shubina et al. 2021). The devices are equipped with smart technology to track users' vital signs, which is ideal for those who voluntarily use contact tracking apps to monitor their physical condition. The connected app can alert healthcare professionals if something goes wrong with their health, and this tracking will be between users and their healthcare providers, all in a safe way.

Technology can be used to monitor users' health and assist healthcare professionals in detecting a probable case of COVID-19 (Binyam et al. 2021). As an option for digital health care, contact tracking apps can help users maintain contact with healthcare workers while providing data to help healthcare professionals better understand infectious diseases and their impact. Tracing programs, by restricting human-to-human interaction, can help save lives or at the very least slow the development of the COVID-19 outbreak. Screening and follow-up of patients can be performed while maintaining social distancing in the population (Zetterholm et al. 2021) As surveillance mechanisms, they may be at risk of abuse, and epidemic surveillance technologies still need to be strengthened.

When adopting epidemic monitoring and surveillance technologies, governments must also tighten rules, regulations, and policy guidelines, as well as control over privacy problems. Citizens should not be worried about the leaking of their privacy, generating unneeded difficulties and hidden threats, because of the contact tracking applications used to manage of the COVID - 19 outbreak.

Supporting provision of health services during the COVID – 19 epidemics

No contact tracing tool can function to its full potential until broad, inexpensive, quick testing and fair access to healthcare are made possible. For the time being, we must remain vigilant to ensure that any contact tracing app is voluntary and used only for public health purposes, and only during this pandemic. By increasing the IoT infrastructure and giving strong privacy assurances, the efficacy of the contact tracking software has been boosted through voluntary user adoption (Garousi et al. 2022)

Early warning and preventative systems can stop unwarranted exposure to dangers to public health (Taipale et al. 2022). After getting a notification from the contact monitoring app, laboratory testing has become a crucial component of containing the COVID-19 outbreak. Users who have been under medical supervision should actively undergo a coronavirus test.

Early alert can lead to improved diagnostic efficiency and minimized misdiagnosis of COVID suspected cases (Rinnikko et al. 2022). During the process of tracing the source of infection of COVID-19 cases and voluntary coronavirus testing of contacts, individuals maybe be identified for epidemiological investigations and opportunistic screening. After receiving an early warning, users of contact tracing apps should visit the medical facility designated by their local health department for prompt examination, diagnosis, and treatment if they have had obvious contact with patients or suspected patients, exhibit symptoms like fever, cough, or sore throat, and are suspected of having corona pneumonia.

Identifying and quarantining contacts of symptomatic cases as well as isolating symptomatic persons are necessary steps to control the spread of disease (Rinnikko et al, 2020). Based on the current evidence, it has been determined how the coronavirus can be transmitted from person to person. The two primary modes of transmission are respiratory droplets and close contact. When people are exposed for an extended period to high aerosol concentrations in relatively tight locations, there is a chance that aerosol transmission will occur. The coronavirus has a certain transmission intensity. If no protective measures are taken, in theory, one patient can transmit the virus to 2 to 3 people, or even more.

Utilizing data, analytics, and dashboards to support the scientific community's planning to acquire information and insights to address the COVID-19 pandemic are important adjuncts to contact tracing (Wang et al., 2021). The COVID-19 pandemic has made it possible to utilize applications over a longer time horizon and at a greater scale. This has improved the tracing of disease spread and will hasten the commercialization of linked digital medical services. For instance, in the early stages of 5G deployment, awareness and acceptance of 5G digital health services were very low. However, with the use of 5G cloud intelligent, remote consultation, with other digital health services in the COVID-19 epidemic's prevention and treatment, prevention of cross infection, efficiency improvement, and other aspects have achieved good results. Favorable user experience will be significantly improved, which is bound to promote these technologies' commercial viability.

Vaccination, immunity, and pharmacovigilance during the COVID – 19 epidemics

COVID-19 vaccines are an effective means of dealing with this disease. Research supports the interdependence between coronavirus vaccines and contact tracing apps. There are no specific treatments now available, and it is not anticipated that the mass distribution of vaccinations in the upcoming years will be enough to stop the pandemic (Wang et al., 2020). As the Omicron coronavirus pandemic spreads globally, there is the possibility of escaping vaccine antibodies, and the COVID- 19 vaccine also requires continuous research and development.

Effective contact tracing and related efforts to slow the spread of disease can reduce the cost and gain the time for new vaccines and new drug development (Wang et al. 2021). The creation and distribution of novel vaccines and medications need in-depth data analysis, literature review, and supercomputing task assistance. With its robust processing capabilities and quick intelligent analysis, artificial intelligence speeds up the drug development process. In response to the urgent need for coronavirus drug research and development, technology companies use intelligent algorithm models to screen compounds, design new drug synthesis routes, predict drug efficacy and safety, predict drug physicochemical properties, predict crystal forms, design drug molecules, and screen biomarkers. Effective tools for vaccination and medication research and development are provided by combination treatment research and other drug research and development linkages. The process of research and development can be increased focus on digital technologies to combat disease spread and treatment options.

Tracking vaccination recipients, monitoring data, and tracking the contact chain will help with the successful distribution of the COVID-19 vaccine (Shubina et al. 2021). Currently, the COVID-19 pandemic is still sweeping the globe, which has had a significant detrimental influence on daily life in the global economy and society. The best approaches to stop the COVID-19 outbreak from spreading further are to create a safe and effective coronavirus vaccine, raise vaccination rates, and gradually build up a population immunological barrier (Wang et al. 2021, Shubina et al. 2021)

6 DISCUSSION

6.1 Reflection on the results

Research suggests that the use of quarantine and contact tracing application can be effective in containing outbreaks in all regions, since everyone is at risk. A crucial component of the COVID-19 outbreak's prevention and control is the tracking of affected people's contacts, and prompt screening can aid in reducing disease transmission. The isolation of confirmed and suspected patients and the identification of close connections are two crucial controls that Finnish authorities have put in place to manage the COVID-19 epidemic. During the COVID - 19 epidemic, many countries have begun to try to use technical means to assist screening. Finland had launched a tracking app called Koronavilkku in August 2020 that uses Bluetooth to record close contact and time between different phones. The total population of Finland is 5.3 million as of June 2022, and the number of users of the Koronavilkku have been over exceeded 2 million. (THL, 2022)

Does Koronavilkku support clinical and practical approaches for COVID-19 pandemic control, first and foremost? The evidence shows that the Koronavilkku application received assistance from a variety of digital health technologies, including technological, social, and epidemiological categories. Studies also demonstrated that when users voluntarily use the contact tracking application for automatic monitoring and tracking, contact tracing applications like Finland's Koronavilkku provide timely information about the temporal and spatial distribution of infected individuals allowing public health authorities to comprehend the present state of the disease and infer the development pattern of the epidemic more accurately. Epidemic data visualization and information prediction using multi-source data acquisition and model prediction technology, and synthesizing the functional requirements of COVID - 19 epidemic data collection, extraction, analysis, and prediction, and the COVID - 19 epidemic information tracking, and trend prediction system are all important control steps and aided by digital technologies like Koronavilkku. The research results show that the Koronavilkku application provided, since it is no longer in use, good information tracking in real-time and high trend prediction accuracy, providing support for ordinary users to observe the COVID - 19 epidemic situation in real time, and helped the regulatory authorities to continue to control the epidemic situation, thereby gaining more time for epidemic control and vaccine promotion (Garousi, Wang, Shubina et al, 2021)

Secondly, how well did Finland's Koronavilkku support the clinical and practical steps taken to manage and ultimately control the COVID-19 pandemic? According to Garousi's study "What users think of COVID-19 contact tracing apps: An Analysis of Eight European Apps," the Finnish COVID - 19 contact tracing app "Koronavilkku" has the highest level of citizen engagement and satisfaction among all 8 European countries, with an average rating of 3,3 to 3,4. (Garousi et al. 2022). The data show that most of the assistance techniques were successful as confirmed by Koronavilkku users.

The findings show that timely contact tracing and thorough testing are crucial components of a successful contact tracing program. Distributing widespread information and tracking real-time spread is critical for pandemic prevention (GDPR. 2016). The identification of infected individuals and their contacts by laboratory testing for COVID-19 and tracking past contacts of an infected person are crucial steps in containing the epidemic. To reduce transmission through isolation and quarantine, the effectiveness of these strategies is to a large extent depends on the timeliness of providing test results and finding and isolating contacts. This means that to have a real impact on propagation, detection strategies need to be well implemented. At present moment, the COVID-19 pandemic is continuing spreading over the world, which has had a considerable negative impact on day-to-day operations in the global economy and society. The COVID-19 outbreak can be stopped from spreading further by increasing vaccination rates and progressively creating population immunity barriers. Safe and effective COVID-19 vaccinations have been produced in several countries.

During the COVID-19 epidemic, nosocomial infections have also happened in several Finnish healthcare institutions. Nosocomial infections, primarily refer to hospital-acquired infections in hospital admissions, including infections that develop while the patient is hospitalized and infections that develop in the hospital after discharge, excluding infections that began before or at the time of admission. Nosocomial infections, which include illnesses of hospital patients, staffs, and visitors who carry pathogens as well as diseases brought on by the invasion or modification of bacteria and viruses in the hospital environment, are also categorized as hospital-acquired infections by hospital personnel.

Anttila in his essay, discussed about the danger of COVID-19 contamination for healthcare professionals working in special care facilities (Anttila, 2020). He gives an example of how Helsinki University Hospital was exposed to this risk due to its COVID-19 pneumonia patients and COVID-19 infected teammates. This study looked at 85 exposures, and 609 healthcare personnel were isolated for 14 days as a result. 74% of at-risk connections were connected to colleagues, whereas 26% were with patients. Only 10 (1.6%) of the 609 healthcare personnel placed in isolation had the COVID - 19 virus infection. After exposure, the virus was caught by 2 of the 85 participants (2.5%). In the same manner, during the COVID-19 pandemic in Finland, there were several instances of cross-infection between patients and medical professionals (THL. 2022). The COVID - 19 pneumonia contact tracking is still primarily manual because there isn't a matching, digital contact tracking app in Finnish hospitals yet. The manager of the department is often the first accountable party for the department's report of a nosocomial infection epidemic. The doctor on duty in the clinical department should immediately report to the hospital infection management department if there is one case of nosocomial infection or more than one suspected outbreak of nosocomial infection. The doctor on duty is also responsible for getting in touch with the hospital infection management department. The clinical department launches infection prevention measures under the guidance of the hospital infection management department. Hand hygiene, selecting gloves, gowns, masks, goggles, or face shields in accordance with the level of exposure anticipated, and safe injections are just a few of the infection prevention procedures that apply to all hospital patients and medical personnel. Wearing the proper protective gear is also necessary while handling contaminated objects and medical equipment in a patient's surroundings. On the premise that the patient's blood, bodily fluids, secretions, and mucous membranes might contain infectious pathogens, standard measures are taken. The ward was shut down, visitors were no longer allowed, and the patient remained in his or her room. Staff needed to disinfect any lesions completely. The department shall be completely cleaned following the discharge, transfer, or death of a patient with COVID-19 pneumonia. There is a need to track the spread of infectious diseases in hospitals, the source of the illness, the route of transmission, and the population that is vulnerable (Työsuojelu. 2022).

In hospitals, where a variety of techniques and technologies are employed to stop the spread of the COVID - 19 virus from patients and carriers to others, contact tracing and isolating the infected and exposed patients and healthcare professionals are currently the primary measures to prevent nosocomial infections. The isolation approach is based on combining traditional manual contact tracking methods with customary measures to quickly segregate exposed and infected patients as well as medical staff members. The hospital develops the necessary isolation and preventive measures in accordance with the COVID-19 pneumonia transmission mechanisms, such as contact spread, droplet spread, and air transmission, in addition to the hospital's actual situation. A yellow sign indicates air isolation, a green sign droplet spread, and a blue sign contact spread. In the isolation ward, signs limiting access and exit for patients and personnel are posted. Patients with COVID - 19 pneumonia or suspected infections are kept apart in a single room, where they are given specialized care and given eye-catching isolation signals. The isolation can be discontinued after five days if all COVID-19 pneumonia symptoms have disappeared, and all laboratory tests are affirmative. The nosocomial COVID - 19 pneumonia pandemic has been effectively contained within the hospital because of prompt tracking, isolation, and preventative measures, as well as broad immunization (THL, 2022).

Finland successfully used big data, 5G, Lot, artificial intelligence, and other information technologies to quickly deploy the contact monitoring application and strongly promote its widespread usage during the prevention and management of the COVID-19 pandemic. Personal data was gathered and accurately and thoroughly analyzed. However, while promoting precise anti-epidemic, these digital health technologies increase the risk of excessive collection and leakage of personal information. As a result, the appropriate laws and regulations should be improved as soon as possible to regulate the use of personal information to address the need to improve the form of personal information disclosure in COVID - 19 epidemic prevention and control, practical challenges with the principle of informed consent, risks in data storage, and other privacy protection challenges. It is important to work towards forming a consensus on privacy protection in the whole society, and to strengthen the research and development of new technologies to reduce the risk of privacy leakage (WHO,2021). This report studies the use and protection of personal information in Finland's contact tracking application - Koronavilkku under the COVID - 19 epidemic and finds that the active use of digital health technology and personal information fighting the epidemic, Finland also follows the EU’s GDPR laws (EU 2016/680, 2016). For the sake of public interest privacy legislation was introduced, and the exceptions to the informed consent of personal information during special periods have been clarified, and the necessity of rights and authority has been clarified to avoid unauthorized expansion. Regarding data collection and storage of users’ data, Finland's Personal Privacy Act legislation makes clear regulations on personal data collection and storage specifications. Technological innovation has led to many applications of emerging technologies such as COVID - 19 contact tracking application procedures and data sharing in the epidemic. Though regulations can be made to govern the gathering, storing, using, disclosing, and erasing of data, etc., they frequently fall behind the pace of technological advancement. It is important to guide and standardize behavior to reduce information leakage and information abuse.

The Finnish Personal Privacy Protection Act specifies the time limit for ending the ability to collect personal data, as well as the time limit for ending the collection of personal data by relevant parties. Accordingly, after the public health emergency is over, information collection, monitoring, and location tracking, among other things, must also come to an end. (Personal Data Act 523/1999). On one side, the COVID-19 outbreak provides a significant challenge to the governance system and governance ability, but it also presents significant opportunity to improve the governance system and capacity. Therefore, in the next stage of COVID - 19 epidemic control, the legislation on personal information protection should be steadily promoted, the security protection of personal information controllers and personal information processors should be strengthened, and the personal information security literacy of the citizens should be improved.

At present, intelligent social governance technology mainly refers to the comprehensive application of computational intelligence, perceptual intelligence, cognitive intelligence, and insight intelligence in information flow management. Its basic operation process includes information input, processing, output, feedback, and other links, among which the most important is the representation of the input data information. The COVID - 19 contact tracing applications are one of the representations that link not only to subjective behavior and trust value but also to objective time and location facts. The scale of facts and values created during this pandemic period are unprecedented. This scale represents the natural union of logical intelligence and perceptual intelligence. Numerous technologies, including artificial intelligence, big data, mobile communication, cloud computing, and blockchain, are supporting the COVID-19 contact tracing application. In essence, the digital contact tracking program shows the direction in which digital technologies are headed while simultaneously serving as a practical training ground for the comprehensive use of these technologies.

6.2 Validity and ethics

Academic ethics can be interpreted as engaging in the main body of academic activities, in the whole process and results of academic research activities, deals with the relationship between individual and other, individual and society, what should be followed is the sum of codes and specifications. Its introduction and upkeep are mostly reliant on the moral acclaim of academics and the public. It can also be understood that the academic subject is unique in academic research activities, determined by economic and academic relations, and depends on public opinion and tradition. It is the morality of researchers in scientific research activities and a special professional ethics. Academic ethics has different levels, such as laws and regulations, school related regulations and scientific research. The research stage is an important stage for the cultivation of academic literacy. To abide by academic ethics, research should strive to follow every detail of accepted academic study and research standards. The most important point is honesty and integrity, including respect for other research results and correct guidance. The research results and statistical data are complete and accurate in this work are consistent with academic standards of accuracy.

Through the academic ethics study of the Savonia university of applied science, the author fully realized the importance of scientific research integrity construction. It is the foundation of scientific and technological innovation. An important part of the construction of the spirit of righteousness is dedication to the promotion of the spirit of science, to maintain the social reputation of science, and to promote the cause of science and technology.

The goal of this research is to evaluate the clinical and operational support and efficacy of the Covid-19 touch tracking application. This study and writing process was long, lasting over six months. The author is not a native English speaker, and academic English is always a challenge for the author. This theoretical study received no external financial support. The author worked full-time at a busy hospital during the writing period. This included multiple infections with the coronavirus pneumonia during this study, and ongoing treatment of post - COVID syndrome. Covid-19 contact tracking application is a novel and complex topic, and materials were sometimes difficult to fully comprehend for purposes of this research. But the author assessed all findings as impartially as possible, and no materials were in plagiarized, and all references were accurately marked according to university guidelines in this study.

7 CONCLUSIONS

The major goal of this study was to perform a narrative literature review of the existing clinical and practical COVID-19 pandemic preventive measures using accessible resources pertaining to Koronavilkku. The analysis of the study concentrated on responding to two research questions through the literature review. The findings of the literature research indicate that the contact monitoring application has played a significant role in the COVID - 19 epidemic's prevention and containment. However, this review is not a comprehensive review of the literature, and there are other viewpoints that have not been included in this work. Moreover, as a new digital technological innovation approach, many studies are in the preliminary stage, and the data collection and analysis coverage are not extensive. Finding appropriate information throughout the search process became challenging as a result. How to enable the improvement of digital governance through the iterative upgrade of the COVID - 19 contact tracking application is a key link that cannot be overlooked in the gradual transition from a social management tool during the epidemic prevention and control period to the provision of digital health services in the post-epidemic era. Introducing a contact tracing app will help the COVID-19 epidemic be controlled, enhance the future, and better prepare for several useful following actions. More clearly than ever, the experience of using contact tracking software to contain the COVID-19 outbreak has demonstrated the urgent need for digital health data that is simple to aggregate, simple to use, and which can help healthcare professionals make sense of the data, implement findings, and improve over time. The success of the Finnish health care system, which saw users voluntarily use Koronavilkku in response to the pandemic, has brought a clearer picture of what to focus on in future public health crises, and involve citizens in the fight against an epidemic. Many nations lack a clear legal and regulatory framework in digital health, and this was made clear during the COVID-19 epidemic and the widespread usage of monitoring technologies. Many digital health innovations are not subject to medical institutions' regulatory oversight. Even though by 2017 there were specific laws protecting personal information in 120 different nations, many other nations still lacked such laws and regulations. Inadequate medical data and device data protection directly contributes to user data privacy concerns, data integrity problems and availability issues, and indirectly drives many users away from digital health solutions, particularly contact tracking programs. Therefore, each nation should set up a methodical, rational, and efficient regulatory framework to safeguard users' autonomy in the realm of digital health. The lessons learned from difficult experience apply to more than just handling a pandemic. They are also broadly relevant to the future of digital health. They reinforce key elements of the digital health concept. During the COVID -19 epidemic contact tracing applications have provided unique insights for updating the concept of digital health relative to person-centered care, business incentives, and cybersecurity.

In the worldwide battle against the coronavirus, the Covid-19 contact tracing software has been crucial. Global strategies for adopting technological solutions, however, start from very diverse places. Governments, communities, and even citizens are willing to create a variety of coronavirus epidemic targeting and detection solutions. These planned techniques include using face recognition or infrared imaging to measure body temperature, voice recognition to identify coronavirus in a cough, location tracking, or alerting people when they cross quarantine limits. It's critical to consider legal and ethical concerns when new digital health technology solutions are developed more quickly, and technology enables new kinds of services. People throughout the world have highly varied opinions regarding pandemic prevention strategies that include gathering extremely private information about people's whereabouts and health. For instance, location may be always tracked in some countries. The beginning of the epidemic's eradication in Asia is heavily governed and regulated, much as privacy data policy is in general. Instead of solutions focused on the collecting of pointless data, the starting point in Europe is more voluntary and privacy conscious. To assure openness and privacy in data exchange, this transforms into the deployment of technology that is sufficiently dependable (Cemal, 2021). This includes, among other things, making sure that the Covid-19 monitoring software does not save encounter location information, and that users consent to communicate their data with specified parties when they download the app. Unusual situations can alter how we behave as individuals, as governments, and as communities in order to recuperate from crises by utilizing technology and developing new innovations to address the evolving wants of society and the general populace. In this new environment, legislators are crucial. Governments hardly ever decide on Covid-19 contact tracking app technologies, but laws may either encourage or stifle innovation. It is uncertain what infectious disease outbreaks will be confronted in the future, and what related infectious illness tracking types of applications need to be produced. It will always be important to regulate the use of tracking apps and consider the ethical considerations involved. Although people now have little control over the details acquired about them and frequently consent unquestioningly to applications or websites collecting enormous quantities of information about them, regulation of data usage is nevertheless necessary (Wäyrynen et al, 2020).

The Covid-19 epidemic has pushed individuals to spend more time at home, using remote network connections and cloud computing services, and overall spending more time online, which has helped some tech giants and other enterprises. Large IT businesses are also reacting to this specific circumstance by creating remote services more quickly than anticipated and giving healthcare professionals and researchers involved in combatting the Covid-19 the technical tools they need to track infection chains. Concerns have emerged over the technology these businesses offer and their moral application of it. The failure to accept good technology solutions might be attributed to the fear of potential exploitation. Future data gathering and utilization will be increasingly crucial, and many of these records will be more directly tied to people's everyday lives and activities. Data is a highly distinct type of raw resource that is not depleted during usage but rather grows. During the COVID-19 epidemic, it is crucial for individuals and local authorities as well as public healthcare institutions to leverage data, digital services, and new technology. Utilizing the tools made available by digitalization has been instrumental in controlling the COVID-19 pandemic, and contact tracing applications have enhanced information flow. Proliferation of digital platforms also offer forums for discussion and group decision-making in unusual situations.

The COVID-19 epidemic is still affecting the health and safety, economic development, and social stability of the world. The harmfulness of the COVID - 19 epidemic, the fragility of the public health and epidemic prevention system and social development, and the incompatibility of governance capabilities have jointly contributed to the emergence, accumulation, and superposition of various problems. In the short term, the COVID-19 epidemic was controlled through special measures during the emergency period and strategy, and as the mutation and virulence of the coronavirus weakened, COVID-19 was downgraded to an endemic infectious disease (WHO, 2022). However, special measures in a specific period also bring many unexpected or unpredictable risks, such as medium and long-term impacts on service trade, commerce, transportation, manufacturing, education and medical care, cultural tourism, etc. Difficulty in employment, declining income, increasing government deficit, debt default, inflation, declining government credibility, social trust crisis, mental health, and other issues have all been seen during the pandemic. An effective emergency response has distinct benefits, and the national system can mobilize effectively when there is a state of emergency, but there is also a tremendous deal of potential for long-term social impact.

Our society can become more functional with the help of technology advancements in digital health, which may also improve wellbeing and simplify people's lives. This can save society a significant amount of money and improve people's lives by being able to utilize technology to predict sickness, and address social marginalization, and stop infectious disease pandemics. By merging information from many public and commercial sector sources, this may be accomplished. Governments should first permit the blending of private sector data with data from either the social services or health care sectors. The European Health Data Space project, which outlines the future of collecting and using health data in Europe, is being coordinated in Finland by THL (Kalliola et al. 2021). As technology becomes more pervasive and gives numerous technical enterprises the chance to innovate to develop entirely new goods and services—and a new sort of society—Finland is recognized for being a technological pioneer. The coronavirus pneumonia pandemic has united people, societal groups, and the government. The rights of privacy could be put in jeopardy if governments allow technology businesses to innovate too freely. But overly restrictive government limits on the utilization of technology or data may prevent the development of many novel goods and services and allow other nations to exceed Finland and make it difficult for Finland to deal with the impending post-crisis recession. Therefore, it is essential to carefully analyze how using digital health care may alter future outbreak prevention and control. Digital Health research, development, and application present prospects for a future based on a more equitable world and increased well-being across all spheres of society.

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APPENDIX

Appendix 1: Characteristics of the selected research (n=7)

Writer and year	Article/research	Research method	Objective of the study	Results
Garousi et al. 2022	What Users Think of COVID-19 Contact-Tracing Apps: An Analysis of Eight European Apps	case study	determine the primary problems with contact tracing applications and analyse user satisfaction	The significant challenges include a lack of citizen involvement, a lack of technical knowledge on the part of users, the application of technological presumptions in various cultural settings, and user privacy and usability. COVID-19 contact tracing programmes are typically unpopular with users, in accordance with the study
Rannikko et al. 2022	Population-Based Assessment of Contact Tracing Operations for Coronavirus Disease 2019 in Pirkanmaa Hospital District, Finland	Case study and interview	Assess contact trancing app's efficiency, effectiveness, and transmission settings.	Data on the primary transmission environment was supplied by the contact tracking app, with high rates of separation and isolation lowering ongoing transmission.

Zetterholm et al. 2021	Digital contact tracing applications during COVID-19	Scoring literature review	What factors could influence contact tracing application acceptability and uptake, and what kind of study might help?	Research may improve the acceptability of contact tracking applications based on: Trust; Privacy concerns; Social responsibility; Projected health hazard; Experience with and access to technology; Performance expectancy and perceived advantages; Understanding; and the intention-action gap.
Shubina et al. 2021	Effectiveness modelling of digital contact-tracing solutions for tackling the COVID-19 pandemic	Mathematical modelling study	Quantify and comprehensively assess the value and efficacy of digital contact-tracing apps.	Established the new compact mathematical model, based on the measurement of the received signal strength review the contact tracking app's performance
Wang et al. 2021	Integrating Digital Technologies and Public Health to Fight Covid-19 Pandemic: Key Technologies, Applications, Challenges and	Systematic Review	Includes a clarification of and overview of the research on digital healthcare, a discussion of its application and difficulties in the COVID-19	The most effective techniques for combating the COVID-19 pandemic are big data, AI, cloud computing, and 5G. Applications

	Outlook of Digital Healthcare		pandemic, and finally an evaluation of its potential in the future.	show how important these technologies are in slowing the spread of the COVID-19.
Taipale et al. 2022	Adoption of a COVID-19 Contact Tracing App Among Older Internet Users in Finland	Questionnair e	Will older Internet users' access to Koronavilkku in Finland be affected equally by demographic background variables, educational attainment, and self-reported health satisfaction?	The Koronavilkku had been extensively embraced by older Finns using the internet (Finnish COVID - 19 contact tracing app)
Garousi et al. 2022	Mining user reviews of COVID contact-tracing apps: An exploratory analysis of nine European apps	Case study	There are insights into the user reviews of nine European COVID-19 tracing applications, and the "software in society" components of the applications are assessed to determine the main problems and areas of concern.	The eight applications under consideration are usually unpopular among consumers; their main complaints centre on high power use and uncertainty about whether the apps perform.