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Master in Community Psychology, Protection of Children and Youth at Risk

Supervisor:
PhD., Sibila Marques, Assistant Professor
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October, 2022

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Department of Social and Organizational Psychology

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*To all who have been a part of my academic journey.*

*Thank you.*

# Acknowledgments

This preamble serves to thank all those who have helped me this year. Without you, this would have been an arduous journey for which I express my deepest gratitude:

To my supervisor, Professor Sibila Marques, for all the support and guidance. For all the knowledge imparted and for all the opportunities to learn and improve. For always being available to help me and answer my doubts. For believing in me, in my work and my efforts. I definitely could not ask for a better supervisor.

To the AIMHealth research team who welcomed me and helped me when needed so that I could complete my master's thesis within the project. My special thanks to the project coordinator, Professor Miguel Sales Dias, who always encouraged me during this journey.

To my parents, Teresa, and José, who supported me in every decision I made in my life. They have given me the opportunity to pursue all my dreams and have always supported me in my will to continue my studies.

To my brother Mauro, who inspires me and pushes me to always want to be better.

To my boyfriend André, who always believes in me and pushes me to believe in myself and not to give up.

To my dearest friend Beatriz who encourages me with her words of support.

Thanks to all of you.

# Abstract

In 2019, the SARS-CoV-2 virus was discovered to cause COVID-19 disease. To contain the virus spread, limiting face-to-face contact was critical, which led to mobile health apps being crucial. For these apps to be effective, they must be accepted by a large portion of the population, which demonstrates the importance of understanding how to motivate their acceptance. The purpose of this study was to examine the influence of persuasive messages on intention to use a COVID-19 health app (AIMHealth) and the role of perceived risk of COVID-19 on this relationship. We also wanted to understand participants' opinions on the main advantages and disadvantages regarding the app. In an online study involving 267 individuals ($M_{age}$ = 36.4), we followed an experimental design and used both qualitative and quantitative measures. Our results showed that there were no differences between experimental conditions regarding the intention to use the app. COVID-19 Perceived risk was found to influence intention to use the app and also to moderate the relationship between persuasive messages and intention to use the app. These findings contribute to the existing literature showing that the communication of these apps must be designed differently depending on the susceptibility of the target audience. Regarding the advantages of the app, participants mainly mentioned the fact that it is a practical way to monitor their health. The disadvantages that stood out the most were participants' privacy concerns. These results are discussed given their implications for the development of effective messages for app adoption.

*Keywords:* Health information and communication technology; mobile health applications; COVID-19 contact tracing applications; persuasive messages; technology acceptance.

*Classification Categories and Codes:*

2260 Research Methods & Experimental Design

3000 Social Psychology

4010 Human Factors Engineering

# Resumo

Em 2019, foi descoberto o vírus SARS-CoV-2, responsável pela doença COVID-19. Para conter a propagação, limitaram-se contactos pessoais, tornando-se crítica a existência de aplicações móveis de saúde. Para que estas aplicações sejam eficazes, devem ser adotadas por uma grande parte da população, revelando a importância do estudo da sua aceitação. O objetivo deste estudo foi entender a influência de diferentes mensagens persuasivas na intenção de usar uma aplicação de saúde para a COVID-19 (AIMHealth), bem como, qual o papel do risco percebido da COVID-19 nesta relação. Este estudo visou também entender a opinião dos participantes acerca das vantagens e desvantagens da aplicação. Através de um inquérito online, no qual participaram 267 indivíduos ($M_{\text{idade}}$ = 36.4), foi realizado um estudo experimental, com recurso a medidas qualitativas e quantitativas. Os resultados revelaram não existir diferenças nas condições experimentais quanto à intenção de usar a aplicação. O risco percebido da COVID-19 estava associado com a intenção de uso, mas também, moderou a relação entre as mensagens persuasivas e a intenção de usar a aplicação. Estes resultados contribuem para a literatura existente, sugerindo que a comunicação destas aplicações seja pensada de forma diferenciada consoante a vulnerabilidade do público-alvo. Relativamente às vantagens da aplicação, foi principalmente mencionado o facto de esta ser uma forma prática de monitorização de saúde. As desvantagens que mais sobressaíram foi a preocupação dos participantes com a sua privacidade. Estes resultados são discutidos no sentido de refletir sobre as formas mais eficazes para promoção de uso deste tipo de apps.

*Palavras-chave:* Tecnologia da informação e comunicação em saúde; aplicações de saúde; aplicações de rastreamento de contactos COVID-19; mensagens persuasivas; aceitação tecnológica.

*Códigos e Categorias de Classificação:*

2260 Métodos de Investigação e Design Experimental

3000 Psicologia Social

4010 Engenharia de Fatores Humanos

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# Introduction

Severe acute respiratory syndrome 2 (SARS-CoV-2) belongs to a large family of coronaviruses. These viruses cause illnesses ranging from common colds to more severe illnesses. SARS-CoV-2 is the virus responsible for COVID-19 disease. This viral respiratory illness can cause coughing, fever, difficulty breathing, pneumonia, and even death, especially in older adults or other adults with pre-existing health conditions. In December 2019, the 21st century changed as a new outbreak of coronavirus began in Wuhan, China, and has since spread worldwide. (Zhou et al., 2020). Due to its spread in most countries, it was considered a public health emergency and declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (World Health Organization, n.d.).

The rapid spread of COVID-19 disease has led to numerous efforts to prevent the pandemic from worsening (Walrave et al., 2021). To contain the spread of the novel coronavirus and encourage less physical contact and hospitalization while reducing the burden and stress on medical personnel, social distancing and quarantine became standard practices (World Health Organization, n.d.). Countries around the world were urged to adopt stringent measures to limit the spread of the virus and prevent overburdening of healthcare systems (Bente et al., 2021). The use of technology was proposed as a measure to be included in countries' strategies to contain the virus (Walrave et al., 2021). Many companies, governments, and civic movements have launched mobile health initiatives to inform and help the public cope with the crisis (Birkmeyer et al., 2020). Mobile health, also known as mHealth, is a general term used to describe mobile technology in healthcare, including cell phones and other wireless technologies (e.g., wearables or telemedicine) (Guo et al., 2016).

To promote social distancing, facilitate doctor-patient communication, and reduce the risk of COVID-19 transmission, various mHealth solutions have been developed (Wang et al., 2020). In particular, mHealth applications include contact tracing and symptom monitoring applications (Budd et al., 2020). These apps have proven to be valuable resources in combating the COVID-19 pandemic and played an essential role in controlling the spread of the SARS-CoV-2 virus (Sharma et al., 2021). These applications allow people to be alerted if they exhibit symptoms consistent with COVID-19 by informing them that they have been in contact with an infected person and advising them to get tested or isolate themselves for the necessary period to prevent the spread of the virus (Bradshaw et al., 2021).

Despite the potential benefits of using health apps, several issues have been raised regarding the potential loss of privacy and security, which impacts their acceptance and adoption (Calvo et al., 2020). Loss of privacy has been identified as an important factor in the acceptance of new technologies. If a user believes their data is not secure, adoption of these new technology initiatives will decrease.

However, for health applications to be effective in combating the spread of the virus responsible for COVID-19, they must be accepted and adopted by a large segment of the population. It is estimated that more than half of the population will need to use these apps to achieve maximum effectiveness (Braithwaite et al., 2020). Because these apps offer immense benefits in containing the spread, understanding how best to motivate their use seemed critical to managing the pandemic (Bradshaw et al., 2021).

To achieve general acceptance, several governments conducted information campaigns about these applications. However, because it can be difficult to convey the functional, technical, and legal aspects of these apps in such campaigns, targeted persuasive messages have been used to address potential reservations. Research on persuasive messages in the adoption processes of this type of technology is still relatively scarce. However, it seems essential to study this topic, as it allows for the updating and creation of health apps tailored to users' needs and concerns, which may be necessary for new pandemic situations (Matt, 2021).

In this sense, this master thesis aims to contribute to the development of mobile applications adapted to users and their concerns by investigating how persuasive messages can influence the intention to use a COVID-19 mobile health app and by exploring users' opinions about this app. To this end, an experimental online study was developed using a mixed-methods approach.

This master thesis is structured as follows: First, an introduction to the topic is given. Following this introduction, the first chapter presents the theoretical background, explaining the current use of technology in healthcare and its importance during the COVID-19 pandemic. Next, the existing literature on the determinants of mHealth app adoption, specifically COVID-19 mHealth apps, is reviewed. Finally, the literature review focuses on presenting the existing literature on persuasive messages and their impact on adopting these apps. The second chapter explains the methodological approach, divided into three sections: participants, instruments, and procedures. In the third chapter, the quantitative analysis is conducted, results are presented, and the findings are discussed. In the fourth chapter, qualitative analyses are conducted, results are presented, and the findings are discussed. Finally, in the fifth chapter, the overall results of the study are discussed, and some aspects, such as the limitations of the present study, its implications, and suggestions for future research, are explored.

CHAPTER 1

# Literature Review

## 1.1. Mobile health apps

Mobile health has evolved through the increasing use of mobile technology and its connectivity to access health-related information (Lee & Han, 2015). Mobile health is broadly defined as the use of mobile devices to support remote health care to provide health services to users (or patients) and improve their health status (Akter et al., 2013).

Mobile health apps, commonly referred to as mHealth apps, aim to promote users' health by providing them with features that help them monitor their well-being and prevent or manage diseases (Aitken, 2015). mHealth apps allow users to record and monitor aspects of their health such as sleep, physical activity, nutrition, vital signs, or reproductive health (Nunes et al., 2019). They range from disease management or self-diagnosis apps to medical apps for healthcare providers or other general health and fitness apps (Boulos et al., 2014). As a transformative service, mHealth aims to improve the well-being of individuals and communities (Ostrom et al., 2010). The use of mHealth can transform health care by making it more accessible, affordable, and available (Akter et al., 2010).

In remote areas, mHealth also enables more people to access health services and provides an alternative solution to some health problems, including health inequity (Istepanian, 2022). Patients can share their health parameters with the appropriate doctor or facility in real-time and as often as needed, avoiding unnecessary doctor visits. This enables both more efficient staff scheduling and costs savings. By enabling patient self-management, mHealth applications can lead to earlier treatment and better health outcomes by detecting diseases in a non-clinical context (Hermans et al., 2015, cited in Woldeyohannes & Ngwenyama, 2017). Chronic diseases can also be treated more effectively through remote monitoring and counselling (Birkmeyer et al., 2021). In this regard, the use of mHealth can improve quality of life by reducing the frequency of hospitalizations and improving financial efficiency (Hardinge et al., 2015).

Mobile health apps could be beneficial when a healthcare provider is not available, or the problem does not warrant a visit to a healthcare provider (Klonoff, 2013). These apps offer several opportunities to strengthen health systems, which makes them valuable resources during health emergencies, such as the recent COVID-19 pandemic, where they were able to play a critical role in containing the spread of the virus (Kondylakis et al., 2020).

### 1.1.1. COVID-19 mobile health apps

During the current COVID-19 pandemic, the development of mobile health services that can help combat the spread of the virus has become much more critical. It has accelerated the digitization of the health sector (Fagherazzi et al., 2020). Various types of COVID-19 apps have enabled health professionals and governments to communicate with the public about the spread of the pandemic. These apps help detect and monitor COVID-19 symptoms and track contacts to help contain the spread of the virus (Budd et al., 2020).

#### *1.1.1.1. Contact tracing apps*

In the first wave of COVID-19, various mobile health apps were quickly developed to combat the virus. The first apps being developed and widely released were contact tracing apps (Singh et al., 2020). Across Europe, more than twenty countries have developed contact tracing apps to improve the management of COVID-19 (European Union, n.d.). In Portugal, the Serviços Partilhados do Ministério da Saúde have also published a contact tracing app, STAYAWAY COVID.

Contact tracing is an epidemiological method used to locate individuals who may have been infected by a person who has tested positive for an infectious disease (Kleinman & Merkel, 2020). Individuals are then asked to isolate themselves from the community to prevent transmission of the disease (López et al., 2020). Typically, contact tracing is conducted by call centre staff who first interview those diagnosed and then alert those who have had contact with them. However, contact tracing can be very time-consuming and labour-intensive. For this reason, contact tracing via smartphones is increasingly being studied and implemented (Raskar et al., 2020).

Digital contact tracing introduces digital technologies into this process to speed it up and reach more people in less time (Chen & Thio, 2021). With digital contact tracing, individuals may use their portable devices to trace their latest contacts. Then, health workers can inform individuals if they have been in near an infected person to let them know that they may be at risk and should be tested or isolated. For example, COVID-19 contact apps can alert people to COVID-19 infections, by designating high-risk areas, so they do not commute to those areas, and they instruct people who have recently been in contact with an infected person to watch for COVID-19 symptoms (Bradshaw et al., 2021).

One can understand that in practice, these requirements mean that the success of digital contact apps depends on a thorough understanding of consumers' willingness to accept and use the app in question (Hauff & Nilsson, 2021). The effectiveness of these apps depends on how well they are accepted by the population because if only a few people use the technology, their effectiveness will be limited.

Due to the COVID-19 pandemic, governments have tried to introduce these apps. However, they have raised numerous privacy concerns that need to be addressed to motivate the population to use contact tracing apps and to better control the spread of COVID-19 (Bradshaw et al., 2021).

Nevertheless, contact tracing apps are not the only ones that can help curb the spread of COVID-19, as other apps have also emerged during this period, such as symptom monitoring apps. These technologies have been used in several countries to monitor patients with suspected or confirmed COVID-19 infection and have several benefits, such as keeping patients safe at home and reducing the risk of transmission to healthcare workers (Bokolo, 2020).

#### *1.1.1.2. Symptom monitoring apps*

Symptom monitoring apps typically collect information about the user's health by asking the patient to fill out questions to identify their symptoms and provide a differential diagnosis. After the user enters his or her symptoms, they usually determine whether he or she has COVID-19 symptoms. If COVID-19 infection is suspected, the user is warned and asked to be evaluated by an appropriate healthcare provider (Singh et al., 2020). However, this method is not the only type of symptom monitoring available. Other innovative methods have been used. Instead of the patient entering their symptoms, some devices allow the user's health-related data (e.g., temperature and pulse rate) to be automatically captured and recorded (Taiwo & Ezugwu, 2020). Combined with wearable devices, it is possible to perform screening and remote monitoring of COVID-19 symptoms at home. Other integrated features, such as direct mobile contact with physicians or telemedicine systems, allow patients to be monitored without the risk of infecting anyone or becoming infected themselves (Singh et al., 2020).

However, these symptom-monitoring apps have also proven have barriers to patient engagement. The main factors that have been a challenge are related to privacy and security concerns (Hussein et al., 2020). Just as with contact tracing apps, a critical factor in the effectiveness of symptom monitoring apps is their acceptance by a large population. In the case of COVID-19 apps, it is expected that more than half of the population will need to use these apps to achieve their full impact (Braithwaite et al., 2020).

## 1.2. Mobile health acceptance

There are many health apps available today, but consumers are often reluctant to use them or do not know that such apps exist (Peng, 2016). Despite their potential benefits, mobile health technologies have encountered several challenges in patient adoption (Or & Karsh, 2009). Although these services are driving positive change, there is growing concern about their perceived quality (Akter et al., 2010). There is uncertainty about the factors that determine the success of these applications (Birkmeyer et al., 2021). According to Shareef et al. (2014), the adoption of mHealth technologies depends on people's willingness to embrace change and replace old habits.

A person's decision to voluntarily adopt advanced technologies is referred to as technology acceptance (Aggelidis & Chatzoglou, 2009). Concerns about technology acceptance have led to numerous research efforts, with the Technology Acceptance Model (TAM) (Davis, 1989) being the most renowned theory in the field (Bagozzi, 2007).

Several studies have used TAM as a central theoretical framework (Vannoy & Palvia, 2010). TAM was introduced by Davis (1989) to investigate why people accept new technologies. This model assumes that technology acceptance is a volitional process. Its goal is to predict and explain the personal acceptance of computer technology, which according to Davis (1989) is explained by five constructs: perceived usefulness, perceived ease of use, attitudes regarding the technology, behavioural intention to use the technology, and concrete use of the technology. Attitudes toward the technology in question and intentions to use it determine the actual use of the technology in question.

According to Davis (1989), the strongest predictor of technology use is behavioural intention (the user's willingness to use the system), which is influenced by perceived ease of use and usefulness. TAM has been criticized for its simplicity, leading researchers to adapt it (Venkatesh & Davis, 2000). As a result, TAM was frequently extended to include other factors, eventually contributing to the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003).

Venkatesh et al.'s (2003) UTAUT is a refined model for studying technology acceptance. Since its inception, UTAUT has been extensively evaluated and provides a rigorous framework for testing acceptance. UTAUT emphasizes the role of usage intentions as a more immediate predictor of actual technology acceptance and use. Variables that determine usage intentions in UTAUT are the performance expectancy, effort expectancy, social influence and facilitating conditions. Venkatesh et al. (2003) further argued that these determinants of intentions interact with some personal characteristics, such as demographic variables, age and gender, previous experience with the technology or similar technological applications, and voluntariness of use (the extent to which use of the technology is voluntary or mandatory).

Recent literature shows that there is still debate about the most reliable model to explain the drivers and barriers to technology adoption (Dwivedi et al., 2019). However, in the extensive literature examining the determinants of intention to use mHealth apps, several studies show that most constructs from these two models consistently emerge as determinants, such as perceived usefulness or performance expectancy (e.g., An et al., 2021; Alam et al., 2020), perceived ease of use or effort expectancy (e.g., Cajita et al., 2017; Cimperman et al., 2013), facilitating conditions (e.g., Napitupulu et al., 2021; Nisha et al., 2015), social influence (e.g., Hoque & Sorwar, 2017; Kamal et al., 2020), and attitude toward the technology in question (Hung & Jen, 2012; Zhao et al., 2018).

Performance expectancy and perceived usefulness capture the same concept and refer to a person's belief in the benefits of using new technology (Venkatesh et al., 2003). In this case, this concept indicates the extent to which the individual believes the mHealth app will help them manage their health. This determinant has been identified as the strongest predictor of intention to use mHealth in several domains, and several studies have shown that the greater the perceived benefit to one's health, the stronger the intention to use mHealth apps (Alam et al., 2020; Alam et al., 2021; Cajita et al., 2017). For example, an app is perceived as useful if it allows users to effectively manage their health or helps them obtain up-to-date and valuable information about their health. When patients perceive apps as useful for their health management, a positive attitude toward the app emerges and leads to a positive behavioural intention to use it (Deng et al., 2012).

Effort expectancy and perceived ease of use are two constructs that capture the same concept: the degree of ease associated with using the new technology in question. When users believe a health device is effortless to use, they expect better performance in managing their health and are more likely to adopt the device (Wang et al., 2020).

Facilitating conditions are the extent to which a person believes they will be supported in using the new technology. This construct includes aspects of environment that aim to remove obstacles to the use of this technology. Facilitating conditions are factors in the environment that either facilitate or hinder the adoption of a technology (Venkatesh et al., 2003). This determinant is an important predictor of intention to use mHealth because when people believe they have a trusted support system to help them, their intention to use mHealth apps is more pronounced than when this perceived support is not present (Bhattacherjee & Hikmet, 2008).

Previous studies have shown that creating supportive conditions improves users' behavioural intentions to adopt technology (Kamal et al., 2020; Napitupulu et al., 2021; Nisha et al., 2015).

Social influence is the degree to which individuals understand that the significant people in their lives believe they should use the technology in question. This construct is based on the notion that a person's behaviour is explicitly or implicitly influenced by how they believe others will view them for using the new technology (Venkatesh 2003). Previous studies have reported that social influence is a key determinant of technology acceptance and that this determinant is positively and significantly associated with the use of digital information and mobile health services in healthcare, suggesting that users are more likely to accept mHealth apps when significant others endorse the use of the app (Alam et al., 2021; Cimperman et al., 2013; Wang et al., 2020).

Attitude toward a particular behaviour is defined as a person's feeling, which may be positive or negative, toward that behaviour (Fishbein & Ajzen, 1975). In theoretical models of technology acceptance, such as TAM, attitude toward technology is mentioned repeatedly. It is a crucial determinant of the intention to use the technology in question. Several studies, such as Zhang et al. (2014), have shown that attitude toward mHealth is a significant predictor of intention to use mHealth, in the way that a positive attitude leads to a higher intention to use.

In the area of technology acceptance, TAM and UTAUT are continually updated and modified to reflect new research showing a variety of other important determinants of technology acceptance. One of the determinants recently studied is trust, which is an important factor in the use of e-commerce (Luo et al., 2020) or digital payment applications (Singh et al., 2020), but also an important factor in the decision to use mobile health services (e.g., Yee et al., 2019; Zhao et al., 2018). Trust is a factor of interest to several researchers, and the results of their studies have shown that it plays a key role in the adoption of m-health apps (Kamal et al., 2020; Nisha et al., 2015).

According to Wei et al. (2009), trust in the context of using mobile health services refers to the scope to which a person considers that using the mobile health service is safe and does not pose any risks. The risks associated with using mobile health services can be of various types, such as privacy, financial, social, psychological, or physical (Kamal, 2020). According to Verkijika (2018), these risks and concerns weaken consumer confidence in the technology and lead to low adoption rates.

A major problem for users is that most medical and health services offered by mHealth apps rely on user data and information that can be misused (Zhu et al., 2021). These technologies require users to disclose personal information (Xu et al., 2009b). Several studies have recognized that protecting individual privacy is critical when disclosing personal information (Dinev et al., 2013). Receiving health advice through mobile technologies, for example, can reduce the need for face-to-face conversations. However, this assumes that users want to use these technologies and feel comfortable disclosing their health-related information, such as their health status and lifestyle. This appears to be difficult, as it has been observed that they are increasingly reluctant to disclose this type of information (Awad & Krishnan, 2006).

Some studies have found that privacy concerns are negatively associated with adopting mHealth applications (e.g., Guo et al., 2016). These privacy concerns discourage the disclosure of personal information, however, mHealth services cannot be offered without collecting this information. This is especially true for COVID-19 contact tracing apps, where reluctance to share personal health data due to privacy concerns jeopardize their success (Fernandes & Costa, 2021). Along these lines, the study of privacy concerns related to mHealth apps has increased in the last two years due to the appearance of COVID-19 apps and the raising concerns about their security (e.g., Birkmeyer et al., 2021).

### 1.2.1. Determinants of COVID-19 mobile health apps acceptance

In the last two years, studies have specifically addressed the factors that drive app adoption in the context of COVID-19. These studies have found that, as with general mHealth apps, some variables from the aforementioned technology acceptance models also appear to influence the adoption of these apps, namely: perceived ease of use (Velicia-Martin et al., 2021) and perceived usefulness (Velicia-Martin et al., 2021; Walrave et al., 2021). Attitudes toward these apps have also been shown to be important in some studies (e.g., Sharma et al., 2020; Velicia-Martin et al., 2021).

In addition to these factors, there are two recurring determinants of acceptance of these apps: perceived risk of COVID-19 infection (Guazzini et al., 2021; Li et al., 2021; Jansen-Kosterink et al., 2020) and privacy concerns about using these types of apps (e.g., Sharma et al. 2020; Walrave et al., 2021; Altmann et al., 2020).

Brewer et al. (2004) noted that most health behaviour theories agree on the predictive role of perceived risk for preventive behaviours. The health belief model assumes that people take health-related actions only when they feel vulnerable to a disease or experience the severity of a disease (Janz & Becker, 1984). Perceived disease threat had a positive impact on the adoption of diabetes management apps (Zhang et al., 2019), and in another study among hypertension patients, it also impacted their intention to use mHealth technology (Dou et al., 2017).

Risk perception is critical to the public's willingness to take health-promoting actions. The public's perception of disease risk significantly affects the success of controlling the spread of a highly contagious disease (Alqahtani et al., 2021). People's perceptions of risk may lead them to engage in precautionary behaviours, such as staying home, avoiding public gatherings, distancing themselves physically, and practicing personal hygiene (Yildirim & Guler, 2020).

Thus, it has been proposed that individuals particular understanding of risk may change their behaviour in this COVID-19 pandemic situation (Li & Zhong, 2022). Dryhurst et al. (2020) said that risk perception of COVID-19 is associated with the adoption of preventive behaviours against the disease.

Most digital contact tracing apps are designed to inform users that they have been into contact with an infected person, so that if they have also become infected, to reduce the likelihood that they will spread the disease (Ferretti et al., 2020). Therefore, a person that believes is being threatened by the risk of being infected with COVID-19 might use a contact tracing app to protect themselves (Chopdar, 2022).

Concerning contact-tracing apps, Guazzini et al. (2021) showed that higher COVID-19 risk perception was associated with contact-tracing apps higher adoption rates. According to Li et al. (2021), COVID-19 risk perception had a significant association with intention to adopt a contact tracing app, with individuals with higher COVID-19 risk perception having higher intention to install and use contact tracing apps.

Intuitively, if people are at high risk for disease, they should be more concerned about their health, which would likely increase their willingness to use contact tracing apps, even though it may come at the expense of their privacy (Chan & Saqib, 2021). These findings are also supported by Ross (2021), who also found that people who believe COVID-19 is a dangerous disease, consider themselves at risk, and rate the likelihood of infection as high are more willing to use contact tracing apps than those who do not.

Privacy concerns also pose a major challenge to the adoption and use of COVID-19 contact tracing apps and are consistently cited in various studies as a factor that reduces intentions to use these apps (e.g., Sharma et al., 2020; Chan & Saqib, 2021). Privacy concerns reflect consumers' concerns about companies using information for purposes other than those stated or intended by consumers. These privacy concerns are increasing as companies adopt various new tools to collect user data (Bandara et al., 2020).

Because COVID-19 apps need to track people's interactions with others, privacy concerns undermine their support and acceptance. Sharma and Bashir (2020) noticed that some COVID-19 apps do not protect users' data in an anonymous, encrypted, and secure manner, while requiring for users to share personal and sensitive data. These privacy violations led people to become more anxious and hesitant, fearing that third parties could access their data, thus reinforcing their desire to protect their privacy.

Although the potential benefits of contact tracing are becoming more apparent, the problems associated with the potential for surveillance and the fear of losing control over personal data are increasing (Calvo et al., 2020). Therefore, there is an undeniable need to gain users' trust so that they feel safe sharing their health data (Hussein et al., 2020).

### 1.2.2. Privacy Paradox in mobile health apps

There is little research on privacy concerns in the mHealth context or the context of privacy-sensitive apps (Fernandes & Costa, 2021). Research on privacy has been developed primarily in the areas of e-commerce and social media (Smith et al., 2011).

Research addressing the factors that motivate or discourage consumers from disclosing information online is generally based on Privacy Calculus Theory (Culnan & Armstrong, 1999). This theory assumes a privacy paradox that occurs when people use digital applications or services, even if it means disclosing their personal information, despite expressing significant privacy concerns (Norberg et al., 2007).

The privacy paradox has been explained as the acceptance and use of mobile applications based on a calculated decision in which consumers perceive the benefits of use to outweigh the costs of privacy. The use of a particular digital service does not mean that individuals do not perceive it as risky or that the service does not represent a potential breach of integrity, but that these risks are outweighed by the significant benefits (Hauff & Nilsson, 2021). As early as 1973, Laufer and Wolfe introduced Social Exchange Theory and referred to the cost-benefit relationship as Privacy Calculus. The Privacy Calculus theory examines people's attitudes and behaviours regarding privacy. This theory states that the positive factors that influence behavioural intentions are the perceived benefits and the negative factors are the perceived risks (Laufer & Wolfe, 1977). According to Xu et al. (2009a), users weigh benefits and risks when disclosing personal information and disclose personal information when the perceived benefits exceed the costs.

It is important to understand this paradox because privacy concerns may determine how users interact with health technologies and affect ultimate health outcomes, as people with greater privacy concerns may not use them (Zhu et al., 2021). This theory may also explain why privacy concerns do not always prevent consumers from disclosing personal information (Aguirre et al., 2016).

In the healthcare industry, for example, people are seriously concerned about how their health data will be used and whether they can control the dissemination of that data. Because healthcare collects sensitive information, people may be unwilling to provide their data despite the high expected benefits of healthcare services because the perceived risks may outweigh the perceived benefits (Kim et al., 2019).

However, despite their increasing popularity, the literature on digital health remains limited. The risk-benefit trade-off of the Privacy Calculus and its influence on mHealth adoption are poorly researched, with some notable exceptions such as Zhu et al. (2021) and Zhang et al. (2017). They applied privacy calculus theory to mHealth services and online health communities. Zhang et al. (2017) showed that the calculus of risk and privacy plays a significant role in individuals' decisions about protecting their health data. Zhu et al. (2021) found that perceived benefits have a stronger influence on users' disclosure intentions than privacy concerns, further supporting the existence of the privacy paradox in the mHealth context.

In general, privacy concerns are critical to the adoption of mHealth services, as customers are uncertain about how providers behave and how their data will be accessed and used (Guo et al., 2016). This is especially true for COVID-19 contact tracking apps, where reluctance to share personal health data due to privacy issues could jeopardize success (Fernandes & Costa, 2021).

#### *1.2.2.1. Privacy paradox in COVID-19 mobile health apps*

The literature is still very sparse regarding the study of the privacy paradox in COVID-19 tracing apps (Fernandes & Costa, 2021).

The study by Bonner et al. (2020), conducted in Germany and Switzerland, shows that participants acknowledge the benefits of COVID-19 apps and confirm that privacy reservations are the main barrier to adoption. The authors affirm that their empirical results confirm the existence of a privacy paradox in the adoption of these types of apps. Tran and Nguyen's (2021) study also found that users make trade-offs between health and privacy risks when evaluating and deciding whether to use contact tracing apps.

The Portuguese study by Fernandes and Costa (2021) also showed that perceived benefits and privacy concerns influence the acceptance and disclosure of personal data, confirming the existence of a privacy paradox. However, this study re-examines the calculus of privacy by incorporating societal benefits and moving from a traditional "egocentric" approach to an "other-centric" perspective. It asserts that the new circumstances surrounding the COVID-19 pandemic require a new approach to the calculus of privacy as consumers consider personal and societal benefits when deciding whether to disclose health data through contact tracing apps. Moreover, the societal benefits of contact tracing apps may make the privacy risks seem small. This study advances previous research by re-examining the calculus of privacy from this new perspective of social exchange and providing empirical evidence that contact-tracking apps appear to be an extreme case of the privacy paradox, where data disclosure can occur despite privacy concerns for a "greater good." According to Fernandes and Costa (2021), it is important to know which benefits should be highlighted and which concerns should be minimized to successfully promote these apps.

Several governments have conducted effective online information campaigns to achieve widespread adoption of contact tracing apps. Considering that the factors driving or hindering disclosure are not uniform across individuals, while mass adoption is needed for contact tracing apps to work, governments and health organizations face a complex situation (Trang et al., 2020). According to Matt (2021), it is challenging to communicate all the features and aspects of contact tracing apps. Therefore, in these campaigns, they have begun to use persuasive messaging highlighting the societal benefits and privacy features to counter potential objections. However, he pointed out that inadequately persuasive messages could cause people to develop unfounded fears that discourage them from using contact tracing apps. Therefore, it is not only important to develop an app that addresses users' concerns, but also to understand how to improve their communication through appropriate persuasive messages that help improve adoption.

## 1.3. Persuasive Messages

According to Stiff and Mongeau (2016), any message that aims to reform, compel, or modify people's responses can be called persuasive communication. Persuasive communication can be used in product presentations to influence people's decisions, attitudes, and practices. It can be presented in a variety of formats, such as video, audio, or written, and it can be communicated in a variety of ways, such as in person or online.

Framing is a type of persuasion in which a source manipulates the content of a communication, defines the fundamental problem underlying a particular topic, and presents a set of thoughts about that topic. A framing effect occurs when a person uses this manipulated content as a framework to make sense of the problem and decide on a particular course of action (Entman, 1993).

One root of the influence on framing research can be traced to the early work of Kahneman and Tversky (1981) in decision sciences. They exposed participants to numerically equivalent scenarios but presented them in terms of losses and gains. These researchers showed how small, subtle changes in the content of the presentation significantly altered the meanings participants attributed to them and dramatically influenced behaviour.

Levin et al. (1998) characterised three varieties of framing: attribute, risky choice, and goal framing. Risky choice involves manipulating a set of alternatives with varying degrees of risk and probability to influence people's risk preferences. Attribute framing uses different expressions of attributes or properties of specific events or objects to influence how people evaluate an object. Finally, in goal framing, different expressions of the outcome or potential goal of a behaviour are used to influence people. Among these types, attribute framing is the simplest method for researchers to understand how people perceive each framing alternative.

Attribute framing can be considered a special type of persuasive communication and involves the use of different expressions of attributes or characteristics of certain events or objects to influence how people evaluate that event or object. Framing refers to the phenomenon that occurs when the presentation of simple and unspectacular changes in a product presentation leads to changes in people's decisions (Kuehberger, 1998).

Even experts are not immune to the framing effect. According to Duchon et al. (1989), when experts make professional decisions within the scope of their expertise, they may behave in a biased manner depending on the frame. These authors found that engineers tend to approve more funding for projects whose past success has been framed positively than for projects whose failure rate has been framed negatively.

According to Angst and Agarwal (2009), the content of a message is expected to positively influence behaviour if the design of the message evokes positive feelings. Therefore, messages that remind people of something negative do not usually lead to a significant change in a person's attitude or behaviour. This process occurs because positive labels evoke positive associations in memory, whereas information with a negative association evokes unfavourable associations in memory.

Public health advocates often use persuasive messages to motivate people to adopt healthy behaviours or change unhealthy ones. The wording of health messages may highlight the positive consequences of the behaviour and the outcomes of that health behaviour - in which case it is a profit-oriented message - or it may emphasise the negative consequences of an unhealthy behaviour - in which case the message is designed to be loss-oriented (Gallagher &

Updegraff, 2012). Health psychologists have long studied the effects of health messages on individual behavioural decisions (Rothman & Salovey, 1997).

### 1.3.1. The effect of Persuasive Messages in health

Most health-related messages can be presented in a way that focuses on the gains or losses related with a particular behaviour, and the formulation of such persuasive messages can influence health decision making (Rothman & Salovey, 1997).

An expanding amount of literature is dedicated to the issue of which form of framing is more successful in which situations and why (e.g., Gallagher & Updegraff, 2012). According to Riet et al. (2014), ever since Meyerowitz and Chaiken's (1987) initial work about framing health messages, the concept of risk has been key to this area. The most convincing explanation for the effects of message framing is that the effectiveness of the information associated with a gain or loss varies on the risk related to the recommended behaviour. They argue that messages associated with gains are particularly effective in promoting safe behaviours, and that information associated with losses is more effective in promoting relatively risky behaviours. For example, a risky behaviour, in their view, would be disease detection behaviours, because these types of behaviours can lead to individuals being found to be ill, which they believe is a risk, making this behaviour a risky one. However, when potential gains are highlighted, people are generally less willing to choose risky options to secure those gains, for example, behaviours that are seen as helping in preventing illness, like, practising physical activity, should be seen as not risky, in contrary, the risk that there is, is not to practice the behaviour, and being at risk of becoming ill (Rothman & Salovey, 1997). Along these lines, they suggested that gain-oriented messages ought to be more persuasive for disease prevention behaviours (non-risky behaviours), such as exercise and other health maintenance interventions, while loss-oriented messages ought to be more persuasive for disease detection behaviours. In Hsiao's (2002) study, Rothman and Salovey's (1997) predictions were confirmed in the context of regular exercise. Positively framed messages elicited greater behavioural intention to exercise regularly than negatively framed messages when the behaviour was viewed as prevention oriented. Overall, participants seemed to prefer messages that were either positively framed or prevention oriented.

Health psychologists have highlighted the relative effects of gain and loss-oriented appeals on various health-promoting behaviours, with gain-oriented appeals showing advantages in achieving preventive health behaviours (e.g., Gallagher & Updegraff, 2012). This is because the information that is associated with a gain appears to make people risk averse. Information that is associated with a gain rather than a loss might lead individuals with high perceived risk to choose the low-risk option of taking preventive action.

Riet et al. (2014), reviewed several studies that have found evidence that risk perception is a central moderator of framing effects. However, the specific direction of this effects still warrants further exploration. In fact, many of these studies followed the risk-framing hypothesis, which states that messages with gain framing are more convincing than messages with loss framing when perceived risk is low, whereas messages with loss framing are more influential than messages with gain framing when perceived risk is high (e.g., Gallagher et al., 2011; Hwang, et al., 2012). For example, the study by Gallagher et al. (2011) examined whether perceived susceptibility to breast cancer influences women's responses to advertising messages about mammography by moderating this relationship. The role of the moderator was confirmed. Women with high perceived susceptibility to breast cancer were found to be more likely to attend cancer screening tests, especially if they saw a message framed in terms of losses compared with a message framed in terms of gains. However, in Riet et al. (2014) review he also describes other studies that have not found this effect (e.g., Lalor & Hailey, 1989; Millar & Millar, 2006). In fact, in Lalor and Hailey (1989), study they examined the influence of framing, by using two different pamphlets, one that stresses the positive consequences of performing breast self-examination, and one that stresses the negative consequences of not doing breast self-examination. They hypothesized that there would be an interaction between brochure type and level of susceptibility, with the largest effect occurring in the group with low perceived susceptibility that received negatively framed brochures. However, the hypothesized interaction did not occur, nor was there a significant effect for brochure type.

Riet et al. (2014) introduced the idea that the way the risk frame theory has been followed in recent years does not seem logical, which can possibly explain why this hypothesis is not always confirmed in the different studies. He explains that if the risk framing hypothesis is true, the effect of framing is affected by the risk linked with the behaviour mentioned. In the case of prevention interventions, the risk perception of a disease, for example, a smoker's assessment of lung cancer risk, does not directly influence the risk associated with the advised intervention, for example, cessation to smoke. A smoker who perceives to be at risk for lung cancer must instead view the decision to continue smoking as risky. Riet et al. (2014) affirms that, as the risk framing hypothesis suggests, information about the positive consequences of healthy behaviours makes people risk averse. In this sense, information aimed at a gain rather than a loss would particularly encourage a smoker with increased perceived risk to quit smoking. Regarding detection behaviour, it is particularly risky for individuals with high perceived susceptibility not to perform the detection behaviour because it puts them at risk of becoming extremely sick if they do not detect it. For example, in the case of the smoker, this author contends that, based on the notion that gain-oriented information makes people risk averse, gain- rather than loss-oriented information should lead recipients with high perceived vulnerability to choose the low-risk option of the detection behaviour by, for example, performing the lung cancer screening.

Nevertheless, the important message to retain is that, regardless of the doubts still surrounding the effects of specific factors (i.e., risk perception), there seem to be general consensus about the important role played by persuasive messages on the promotion of health behaviour (Rothman & Salovey, 1997).

### 1.3.2. The effect of persuasive messages on mobile health apps adoption

Theories of technology acceptance, such as UTAUT, can better understand customers' attitudes and intentions toward technology use and the underlying decision process. However, heuristics also influence decision-making, such as the design of information presented to a target audience (Tversky & Kahneman, 1986).

In new technologies, acceptance depends partly on how potential users view the potential benefits or risks. Research has shown that presenting information in terms of potential gains (what one gains by using a service) or losses (what one loses by not using a service) can have different effects on decision-making, which means whether the service is used or not (Kurila et al., 2016). The results suggest that people show more positive attitudes and behaviours toward artificial intelligence and its suggestions when the service is presented positively than negatively (Kim & Song, 2020). Lim & Noh (2011) found that messages associated with gains have an advantage over messages associated with losses in increasing users' intention to use a fitness app. Nguyen's (2011) study also found that framing messages focused on positive reinforcement helped increase users' engagement with an exercise app.

#### *1.3.2.1. The effect of persuasive messages on COVID-19 mobile health apps adoption*

The COVID-19 pandemic challenged scientists and public health professionals to quickly bring about widespread and substantial behaviour change, particularly when it came to the use of COVID-19 apps, because understanding how best to motivate the use of contact tracing apps seemed critical to address the COVID-19 pandemic (Bradshaw et al., 2021). Also, in this context gain-framed messages have an advantage over loss-framed messages. Specifically, within this context, studies have found that gain-framed messages emphasizing social (rather than just personal) benefits seem to work more effectively.

According to Lewis et al. (2007), appeals that use prosocial language can significantly influence the effectiveness of health campaigns. For example, describing prosocial actions that can lead to positive outcomes in the face of health problems can evoke positive emotions such as hope or joy, leading to greater acceptance of the message because the issue seems more relevant (Nabi et al., 2018). Indeed, some recent research suggests that prosocial health messages that emphasize behaviours associated with societal and community benefits, rather than focusing on behaviours that benefit only one's well-being, are a particularly effective method for communicating public health recommendations in the context of COVID-19 (Jordan et al., 2020). According to Morch (2021), several studies show that people are willing to disclose health information for the public good. Intention to disclose private health information when using contact tracing apps is greater when individuals were made aware of the public benefit than when they were aware of the personal benefit. Therefore, promotional messages may increase the uptake of disease disclosure apps by focusing more on the public benefit than the personal benefit of disclosure. However, it may be beneficial to communicate both types of benefits.

In the study by Trang et al. (2020), they sought to understand how contact tracing apps should be specified to achieve mass adoption. They used a full factorial 3 between-subjects design (benefit appeal: self vs. societal vs. self and societal) x 2 (privacy design: low vs. high) x 2 (convenience design: low vs. high). The manipulation stimulus was a presentation of the app and its features on a mock product page of an app store, with the visual aspect and text introducing the app changed depending on the condition. After participants were exposed to one of the treatments conditions, they answered questions related with the installation intention (dependent variable) and anxiety about coronavirus, general privacy concerns, and information technologies (IT) self-efficacy. Based on the results they found, they created a categorization of people with different tendencies to accept the tracing app and divided them into three groups: the critics, the undecided, and the advocates. Their results show that for the critics, it is important to focus on communicating the social benefits while also minimizing the privacy risks. For the undecided citizens, it is even more important to emphasize the societal benefits, while privacy design remains important. For advocates of contact tracing apps, none of the benefit appeals are paramount, and privacy is suggested to be put on the back burner because advocates would not penalize a privacy waiver.

Following a similar line of studies, Matt (2021) planned a study with an experimental framework to examine the effects of various benefits and risks on intentions to adopt a contact tracing app, and to understand how persuasive messages that address societal benefits and privacy guarantees, can influence people's decision whether or not to adopt the app. To do this, he used a two-group web experiment in which participants were randomly divided into two groups that differed by the persuasive message they received (both in gain-framed format). One group received the persuasive message "Societal Benefits," which highlighted the benefits of the search app in protecting society. The message also indicated that by using the app, they could be helping to protect their friends, families, and the older people and disadvantaged. An attempt was made to appeal to the community and solidarity of the participants. The second group received the persuasive message "Privacy Assurance," which stated that the source code was open so that anyone could check the code, and that a trusted national reviewer had confirmed the privacy and safety of the app. After the manipulation, the entire sample was presented with an identical questionnaire to rate their insights regarding the intention to adopt the app. Among other more general questions (e.g., perceived severity of the pandemic, demographics), this questionnaire also included measure on the health benefits, the expected value of the app for society and its perceived privacy risks. First of all, it is important to refer that the study did not find a significant difference between the intention level among the two experimental conditions. In fact, both emphasizing societal benefits or privacy risks seemed to work equally well, being associated with medium/high levels of intention. However, reasons for the adoption differed among the two experimental conditions. As expected, results showed that in the Societal Benefits condition, the most important predictors of the intention to use the app were the expected value for society and perceived privacy risks. In contrast, in the Privacy Assurance group, the key predictors changed substantially. Here perceived privacy risks and perceived health benefits assumed the leading role (while the expected value for society was no longer significant).

In this sense, Matt's (2021) findings show that persuasive messages focused on societal benefits have the potential to stimulate the societal aspect in the decision-making and eclipse the value of individual health benefits. However, on the contrary, persuasive messages that focus on ensuring privacy may cause individuals focus on their own personal gains and losses in decision-making, stopping to think about the society gains. In sum, the results by Matt (2021) prove the importance of emphasizing different message attributes (despite them being in a gain format): In the "societal benefit" scenario, people appear to want to contribute to the greater good, without worrying too much about anything other than the risk to privacy, and even regardless of the perceived personal health benefits. In contrast, in the "privacy assurance" condition, people think primarily about what is "in it" for them, which could fade out the higher cause of pandemic control. However, in Matt’s study, both types of messages seemed to be associated with medium/high levels of intention to use the app.

However, despite its novelty, Matt's (2021) study has relevant limitations. First, it is not possible to understand the specific effects of different types of messages in comparison with a control group. For instance, it is unclear whether any of these conditions would lead to higher acceptance than, for example, a simple information condition. In addition, we would expect higher acceptance when both solidarity and privacy are emphasized, as Trang et al. (2020). However, the study by Matt (2021) does not allow for this test. Moreover, it is unclear whether these effects would hold for other groups of people, as Matt's (2021) results were found in one particular culture, German culture. For instance, it is not clear whether the effects of the solidarity dimension would even be stronger than privacy assurance in more collectivistic cultures such as, for instance, the Portuguese one (Hofstede, Hofstede & Minkov, 2010).

In Portugal, the only two studies we found on the adoption of mobile health applications, did not focus on the effect on message framing. In fact, the Nunes et al. (2019) study focused on the adoption of mobile health apps in general and on the determinants of acceptance and its moderators, guided by the Unified Theory of Acceptance and Use of Technology. On the other hand, the study by Fernandes and Costa's (2021) focused specifically on the adoption of COVID-19 contact tracking apps and sought to understand the factors that drive or hinder adoption and disclosure, based on Privacy Calculus Theory. However, it also did not include any use of persuasive messages.

These limitations justify the need for further studies on this domain both to further explore the specific role played by different types of persuasive messages and also to replicate Matt’s (2021) findings in other cultural contexts, such as, for instance, the Portuguese one.

### 1.4. Present Study

This study aims to contribute to developing applications adapted to users and their concerns by investigating how persuasive messages can influence the intentions to use a COVID-19 mHealth application. In particular, this study will focus on a specific app named AIMHealth app.

The AIMHealth application is part of the project FCT DSAIPA/AI/0122/2020 AIMHealth -Mobile Applications Based on Artificial Intelligence for Public Health Response. The AIMHealth project is funded by FCT (Portuguese Foundation of Science and Technology) and is hosted by the Information Sciences, Technologies, and Architecture Research Centre (ISTAR-Iscte) of the University Institute of Lisbon – Iscte Instituto in collaboration with the Centre for Psychological Research and Social Intervention (CIS-Iscte).

This project arose from the fact that during the pandemic there was a need to develop solutions that would prevent the spread of the SARS-CoV-2 virus responsible for the disease COVID-19. A technological trend has emerged in the use of contact tracing applications to inform users and health authorities of the possible or actual spread of the virus. However, this approach has raised security and privacy concerns among users. To contribute to public health strategies with a preventive approach, the AIMHealth project aims to develop a smartphone application and artificial intelligence-based service platform to identify symptomatic and asymptomatic patients and their risk of infection. This app, currently in development, will serve two distinct purposes: Recording various health parameters such as heart rate, oxygen saturation, and body temperature, allowing remote monitoring of patients from high-risk groups (diabetics, hypertensives, cardiac patients); and establishing a COVID-19 diagnosis and follow-up of COVID-19 patients in an outpatient setting. This application evaluates the user's risk of contracting the virus to advise them to take a COVID-19 test (Centro de Investigação em Ciências da Informação, Tecnologias e Arquitetura, 2021).

This study aimed to investigate the effect of persuasive messages on the intention to use the AIMHealth application and to understand users' opinions about this app. For that, this study used a quantitative approach to understand the impact of persuasive messages on intention to use the AIMHealth app and an exploratory qualitative approach to capture users' opinions about the pros and cons of the AIMHealth app.

In this study, we aimed to replicate Matt's (2021) study in the Portuguese context and specifically to promote the AIMHealth app. We chose a similar experimental paradigm, although we have introduced some important changes. First, we included two additional conditions: a Societal Benefits & Privacy Assurance condition and a control condition (information only). So instead of two, this study allows us to compare four different types of persuasive messages:

(a) Condition 1 - Societal Benefits (b) Condition 2 - Privacy Assurance (c) Condition 3 - Societal Benefits and Privacy Assurance (d) Condition 4 - Informative. The first two conditions are similar to those used in Matt's (2021) study: Societal Benefits condition and Privacy Assurance condition. The third new condition contains messages related to Societal Benefits *and* Privacy Assurance together. According to Trang et al. (2020), we might expect higher effects when social and privacy benefits are combined (Trang et al., 2020). Finally, we also included a control condition in which only informative content about the features of the AIMHealth app is included. Since no particular benefit is highlighted here, we expect this message to have a lower persuasive effect than the other messages in the other three experimental conditions.

In this study, our goal is to test the effect of persuasive messages on the same concept as in Matt's original study (2021), namely the behavioural intention to use the app. In comparison with the German culture, the Portuguese culture scores lower in individualism (Hofstede, Hofstede & Minkov, 2010). On the other hand, studies conducted with representative samples show similar levels of concern with digital data sharing in Germany and in Portugal (according with the Special Eurobarometer 503 around 60% would not share their data even for health promotion purposes) (European Commission, 2020). Hence, in the case of the Portuguese sample we assume that a condition emphasizing solidarity, especially linked with data privacy messages would be the most effective.

To better understand this phenomenon, we also wanted to investigate the role of perceived risk of contracting COVID-19 on the impact of different types of persuasive messages on the intention to use the AIMHealth app. We know from the literature that not everyone perceives disease in the same way, which can affect the adoption of precautionary behaviours (Brewer et al., 2004). Public perception of disease risk significantly affects the success of controlling the spread of a highly contagious disease (Alqahtani et al., 2021). People's perception of risk may lead them to adopt precautionary behaviours, such as staying home, avoiding public gatherings, physically distancing themselves, and practicing personal hygiene (Yildirim & Guler, 2020). Specific to the COVID-19 condition, studies found that individuals with a higher perception of risk for COVID-19 infection have a greater intention to use contact tracing apps (e.g., Guazzinni et al. al, 2021; Li et al., 2021).

Based on the literature examining the role of perceived risk as a moderator of message framing in health decisions, we decided to evaluate the role of perceived COVID-19 risk as a moderator of the relationship between persuasive messages and intention to use the AIMHealth app. Following the idea that perceived covid-19 risk could be influential in the decision to use the AIMHealth app, that in this study was presented in a gain-framed way, as a possible preventive behaviour for contact tracing. To our knowledge, this moderator role has not been previously assessed in either general mHealth apps or contact tracing apps, making this analysis a first in the field. Based on Riet (2014) proposal, we assume that individuals with higher perceived risk of COVID-19 will respond better to the gain framed messages, than individuals with lower perceived risk, in a way that they will have a higher intention to use the AIMHealth app.

Hypothesis for the present study are as followed:

H1: Individuals in the Societal Benefits *and* Privacy Assurance (C3) experimental condition have a higher intention to use the AIMHealth app than in the other three conditions (Societal Benefits [C1], Privacy Assurance [C2] and Informative [C4; control condition] alone).

H2: Higher perceived risk of COVID-19 is associated with higher intentions to use the AIMHealth app.

H3: Perceived risk of COVID-19 moderates the effect of persuasive messages on the intention to use the AIMHealth app in the sense that effects will be better in individuals with higher than with lower risk perception of COVID-19.

Moreover, besides testing for these specific effects on intentions, the goal of this study was also to explore opinions about the messages transmitted about the AIMHealth app with an open-ended format. Therefore, in addition to quantitative indicators, we also asked open-ended questions aimed precisely at understanding the advantages and disadvantages of the AIMHealth app after being exposed to the persuasive messages.

CHAPTER 2

# Method

## 2.1. Study Design

The present study was conducted using an online questionnaire developed in the Qualtrics platform. The study is an experimental one that includes both quantitative and qualitative measures, so the questionnaire consists of both closed and open questions. After the initial measurement of risk perception related to COVID-19 (moderating variable), participants were randomly assigned to one of four conditions: (C1) a condition in which participants were exposed to a persuasive message that focused on the societal benefits of using the AIMHealth app (*n* = 62); (C2) a condition in which participants were exposed to a persuasive message that focused on ensuring privacy when using the AIMHealth app (*n* = 69); (C3) a condition in which participants were exposed to a persuasive message that focused on *both* the societal benefits of the AIMHealth app *and* the privacy assurance of using the app (*n* = 65); and (C4) a control condition in which participants received an informative message about the AIMHealth app (*n* = 71). After receiving the persuasive messages, participants were asked to complete open- and closed-ended questions about their intentions to use and their overall perceptions of the AIMHealth app.

## 2.2. Participants

The sample includes 267 participants aged between 18 to 70 years (*M* = 34.6; *SD* = 13.4). Regarding participant gender, 191 (71.5%) participants identified themselves as female, 75 (28.1%) as male, and 1 (0.4%) as another gender.

Regarding marital status, most participants were single (56.7%), followed by 25.7% who were married. In terms of academic level, most participants had a bachelor's degree (47.2%), followed by 30.7% who had completed high school. The majority of participants were employed (60.3%), and 22.1% were full-time students.

When asked if they had been diagnosed with a medical condition by a doctor, most participants responded that they had not been diagnosed with a medical condition (73%). 6.7% answered that they had a respiratory illness, followed by 4.5% who reported a mental illness.

Sociodemographic characteristics can be seen in more detail below in Table 1.

**Table 1**

*Sociodemographic characteristics*

| Sociodemographic characteristics | *n* | % |
|---|---|---|
| Age | | |
| 18-27 | 123 | 45.6 |
| 28-37 | 37 | 14.2 |
| 38-47 | 41 | 15.3 |
| 48-57 | 53 | 19.9 |
| 58-67 | 12 | 4.6 |
| 68-70 | 1 | 0.4 |
| Gender | | |
| Female | 191 | 71.5 |
| Male | 75 | 28.1 |
| Other | 1 | 0.4 |
| Marital Status | | |
| Single | 152 | 56.7 |
| Nonmarital partnership | 23 | 8.8 |
| Married | 69 | 25.7 |
| Separated | 2 | 0.8 |
| Divorced | 17 | 6.5 |
| Widowed | 4 | 1.5 |
| Academic Level | | |
| Primary school | 1 | 0.4 |
| Middle school | 6 | 2.2 |
| Secondary school | 82 | 30.7 |
| Bachelor’s degree | 126 | 47.2 |
| Master’s degree | 51 | 19.1 |
| Doctoral degree | 1 | 0.4 |
| Professional Status | | |
| Employed | 161 | 60.3 |
| Unemployed | 12 | 4.5 |
| Student | 59 | 22.1 |
| Student worker | 24 | 9 |

| | | |
|---|---|---|
| Other | 11 | 4.1 |
| Diagnosed Medical Conditions | | |
| Arterial hypertension | 13 | 4.9 |
| Diabetes | 1 | 0.4 |
| Obesity | 6 | 2.2 |
| Cancer | 3 | 1.1 |
| Cardiovascular disease | 5 | 1.9 |
| Respiratory disease | 18 | 6.7 |
| Autoimmune disease | 9 | 3.4 |
| Neurological disease | 1 | 0.4 |
| Mental disease | 12 | 4.5 |
| Other | 18 | 6.7 |
| None | 195 | 73 |

Regarding the COVID-19 situation of participants, most participants have not yet been infected (67.6%), followed by 27.7% who have already recovered. 62.5% had contact with or helped people with COVID-19 during the pandemic, and 68.2% had relatives with COVID-19 in home isolation.

When asked about COVID-19 apps for contact tracing, most participants responded that they were already aware of these types of apps (94%), and the majority had specifically heard of the app STAY AWAY COVID (87.6%). However, only 37.8% of participants had already used a contact tracing app.

The COVID-19 situation of the participants is presented in more detail below in Table 2.

**Table 2**

*Participants COVID-19 Situation*

| Questions about the participants of the study COVID-19 Situation | *n* | *%* |
|---|---|---|
| What is your situation regarding COVID-19 disease? | | |
| Not infected now and never been infected before | 181 | 67.6 |
| In quarantine or active surveillance by health authorities (contact with positive case) | 2 | 0.7 |
| In isolation or mandatory confinement (confirmed diagnosis) | 10 | 3.7 |
| Recovered | 74 | 27.7 |
| Have you had contact with or supported people who have COVID-19? | | |

| | | |
|---|---|---|
| Yes | 167 | 62.5 |
| No | 74 | 27.7 |
| Not sure | 26 | 9.7 |
| Did you have close family members with COVID-19? | | |
| No | 76 | 28.5 |
| Yes, with isolation at home | 182 | 68.2 |
| Yes, with isolation in hospital | 7 | 2.6 |
| Yes, with admission to the intensive care unit | 9 | 3.4 |
| Have you ever heard of the existence of mobile contact tracing applications? | | |
| Yes | 251 | 94 |
| No | 16 | 6.0 |
| What COVID-19 contact tracing apps have you heard of? | | |
| STAYAWAY COVID | 234 | 87.6 |
| Radar Covid | 19 | 7.1 |
| Pingdemic | 1 | 0.4 |
| Coronavírus - SUS | 16 | 6.0 |
| Other | 3 | 1.1 |
| I don’t know any application | 18 | 6.7 |
| Have you used any of the applications mentioned above or another similar application? | | |
| Yes | 101 | 37.8 |
| No | 166 | 62.2 |

## 2.3. Instruments, Measures and Scales

The questionnaire used to collect data for this study is part of a larger project, and in this master thesis, we will present only some of the results of the study. In this sense, it is important to explain that in this section we will only present the measures and scales for the variables analysed in this master thesis (see Appendix A for the full questionnaire used in the global study). Measures used in the present study:

**Demographic Questionnaire.** The demographic characteristics of the participants were collected using a sociodemographic questionnaire that included questions about gender, age, marital status, education, occupational status, and health status (presence or absence of diseases).

**Questionnaire about the participants COVID-19 situation and their use of contact tracing apps.** This questionnaire assessed the participant's situation regarding COVID-19, i.e., whether the person was already infected with COVID-19 or not, whether the person had contact with others infected with COVID-19 or not, and whether the person had close relatives who were infected or not. To understand participants' knowledge of COVID-19 contact tracing apps, they were asked whether they were aware of these apps, which apps they had heard of, and whether they had used these apps.

**Portuguese version of COVID-19 Perceived Risk Scale (Leite et al., 2021).** The Portuguese version of the COVID-19 Perceived Risk Scale was used in this study. Examples of items are: "What is the likelihood that you would acquire the COVID-19 compared to other persons?" and "How worried are you about contracting the COVID-19?". All items were answered on a 5-point Likert Scale (1- negligible to 5 – very large). In the present study, the total score of the COVID-19 Perceived Risk Scale was used, showing good internal consistency (α= .80). An analysis of the psychometric qualities of the scale revealed increased consistency with the removal of Item 3 (with the item 3, α= .76; without the item 3, α= .80). Hence, we chose not to include this item in this measure, like Leite et al. (2021) did in its study.[1]

**Persuasive Messages Manipulation (Matt, 2021).** In the middle of the questionnaire, participants were randomly divided into four groups, and each group received a different message about the AIMHealth app. One group received a message that focused on the societal benefits of using the AIMHealth app (C1), one group received a message that focused on the privacy of using the AIMHealth app (C2), and one group received a message that focused on both the societal benefits and the privacy assurance of the AIMHealth app (C3). One group received only a general description of the app (C4, control group).

The content of the persuasive messages was based on the messages used in Matt's (2021) study. For example, in the group that received a message focused on the societal benefits of using the AIMHealth app, participants were presented with the following message alongside

[1] The original version of this scale (Yildirim & Guler, 2020) showed good psychometric qualities, and the presence of two different dimensions: a cognitive (ranged between .70 and .74) and emotional dimension (ranged between .84 and .88). In the Portuguese version (Leite et al., 2021), the original structure was not confirmed, showing that the scale was multidimensional, including cognitive and emotive aspects of perceived personal risk related to COVID-19, but showing a good internal consistency of the overall scale (α =.84). In the present study, we conducted a factorial analysis and could not replicate any of the structures of these studies, with results showing a three-dimension structure. Since we do not aim to explore in detail the moderator role of different facets of risk perception, for the present study we chose to consider only the global score, that revealed good internal consistency (α =.80).

the descriptive text of the app: "Using this app benefits everyone! Preventing the spread of the virus helps your family, friends, and acquaintances, especially the elderly and most vulnerable".

**Figure 1**

*Message received in the societal benefits condition (C1)*


The image above was presented as an example of the manipulation used in condition 1, the other manipulations can be found in Appendix B, for viewing.

**Manipulation check.** To check whether participants perceived the manipulation correctly, they were asked to indicate, on an agreement scale of 1 to 7 Likert points, the extent to which they agreed that the content of the message they had received focused on: solidarity/greater good for society, data protection/privacy, or none of the above (only general information about the app).

**Open-ended Questions.** After presenting the persuasive messages about the AIMHealth app, two open-ended questions were asked to understand participants' perceived benefits and disadvantages of the AIMHealth app. Questions were “Taking into account the information provided about the AIMHealth app, what do you consider to be the advantages of this app?” and “Taking into account the information provided about the AIMHealth app, what do you consider to be the disadvantages of this app?”.

**Behavioural Intention to use the AIMHealth app.** To measure behavioural intention to use the AIMHealth app, we adapted and translated a scale validated by Cimperman et al. (2016), which has excellent internal consistency ($\alpha = 0.98$). All items were answered on a 5-point Likert scale (1- Totally Disagree to 5- Totally Agree). Some examples of items include "I predict I will use the AIMHealth app on a regular basis in the future" and "Assuming I had access to the AIMHealth app, I would intend to use it".

## 2.4. Procedure

An application was made to the Ethics Committee ISCTE-IUL for permission to conduct this study, which was granted (case file 120/2021).

First, the questionnaire was created in the Qualtrics platform, and a pre-test was conducted. 40 people answered the pre-test questionnaire in an iterative process. Respondents were asked to share their doubts and suggestions for improvement, which served as a basis for modifying some aspects of the questionnaire. Some of the responses came from the members of the AIMHealth research team, who also provided their feedback. Some changes were made in light of these suggestions. Data were collected in February 2022. For data collection, participants were invited to join the study and complete the online questionnaire through the link available on social media: Facebook, LinkedIn, and Instagram. Informed consent was displayed on the first page of the questionnaire and was obtained before completion. Completing the questionnaire took approximately 10 minutes and included answering qualitative and quantitative questions. Finally, a debriefing was conducted to thank the participants for their participation. Participation in the study was voluntary and was not compensated in a financial manner. Given the focus of this study, it is important to explain what the pandemic COVID-19 looked like in Portugal in February 2022. The month began with the highest number of deaths since February 2021 and more than 50,000 daily cases of COVID-19. However, in February, the entire population was assumed to have some immunity to the virus between vaccination and infection. Due to a decline in incidence, a lower transmission rate, and greater responsiveness of the national health system, this has meant that the country has survived the 5th wave of the pandemic without even approaching the red lines established for hospital occupancy, particularly in intensive care units. This month, the review of restrictive measures began with the aim of reducing restrictions and following the example of other countries such as the United Kingdom and Denmark, which lifted all exceptional measures to control the pandemic in February 2022 (Dantas, 2002; Expresso, 2022).

Quantitative data were analysed using IBM SPSS Statistics 28. Analyses were performed considering participants with very long or very short response durations (two standard deviations above or below the mean). For 6 participants, the response duration was outside this range. The analysis was conducted with and without these participants in the sample, and since the results did not change significantly, we decided to keep the total number of participants.

The qualitative data from the two open-ended questions of the questionnaire were analysed using NVIVO software (version release 1.6.1. for Windows). To examine the content of the qualitative responses, inductive thematic analysis was chosen, a data-driven method that allows for the identification, analysis, and detailed description of themes contained in the data (Braun & Clarke, 2006). The inductive analysis involves coding the data without attempting to fit them into a pre-existing coding framework or the researcher's analytic biases. In this sense, this form of thematic analysis is data-driven. Thus, the goal of inductive thematic analysis was to determine the perceived advantages and disadvantages of the AIMHealth application. Given the novelty of the situation and the context of COVID-19, we decided that it would be better to adopt an inductive and open analytical framework that would allow spontaneous themes to emerge.  We followed the steps defined by Braun and Clarke (2006). First: familiarization with the data by reading and rereading the data and noting initial ideas. Second, the generation of initial codes by systematically coding exciting data features throughout the data set and assembling data relevant to each code. Third, searching for themes by grouping the codes into potential themes and collecting all data relevant to each potential theme. Fourth, revision of the themes by looking at the coded excerpts and the entire dataset to create a thematic map. The fifth step was to define and name the themes. This involved continuing the analysis to refine the specifics of each theme and the overall story that the analysis tells, creating clear definitions and names for each theme. The sixth and final step was to write the report by selecting vivid, compelling examples of excerpts, conducting a final analysis of selected excerpts, linking the analysis to the research question and literature, and writing the report.

First, we analysed the entire corpus looking for relevant themes regarding the advantages and disadvantages of using the AIMHealth app in general. Then, we used the cross-tabulation function in NVIVO to examine the differences in themes according to the experimental conditions and risk perception in relation to COVID-19. It is important to add that the data analysis was conducted in a collaborative process with the supervisor of this dissertation, and the themes and subthemes were created in consultation with her. In addition, we also analysed the level of agreement by asking another researcher to code 30% of the analysed corpus. The level of agreement was adequate (Cohen's kappa [k] = .825).

It is important to explain that in the questionnaire we used, the open-ended questions were asked first and then the closed questions, but from now on, in the results section, we will present the quantitative analysis first. This is done because we believe that the results can be better understood in this way, and also because we hoped to further explore the quantitative results with the open-ended questions. However, in the questionnaire, the qualitative measures were presented first because we wanted to solicit participants' opinions free of any bias that might arise if we had asked the closed-ended questions first.

CHAPTER 3

# Quantitative Results:

# Effect of persuasive messages and COVID-19 perceived risk on the intention to use the AIMHealth app

The quantitative part of this study aims to investigate the influence of persuasive messages on the intention to use the AIMHealth app and also to understand whether the COVID-19 perceived risk directly influences the intention to use the app and whether it plays a moderator role in the relationship between persuasive messages and the intention to use the app.

## 3.1. Descriptive statistics of COVID-19 perceived risk and Intention to use the app

The COVID-19 Perceived Risk Scale and intention to use the AIMHealth app, the two continuous variables in the study, were measured on a 5-point Likert scale. In the COVID-19 Perceived Risk Scale, a higher total score indicates a higher COVID-19 perceived risk. As the results in the table below (Table 3) show, participants in this study perceived a low COVID-19 risk. Regarding intention to use the AIMHealth app, higher scores mean higher intention to use the AIMHealth app. As the following results show, participants in this study have a neutral opinion regarding their intention to use the AIMHealth app.

A correlational analysis was performed between these variables. As we can see, there is a statistically significant positive correlation between COVID-19 risk perception and intention to use the AIMHealth app ($r = 0.19$; $p < 0.01$).

**Table 3**

*Descriptive statistics and correlation between the variables in study*

| Scale | M | SD | *Mdn* | Min | Max | 1. | 2. |
|---|---|---|---|---|---|---|---|
| 1. COVID-19 Perceived Risk | 2.93 | 0.74 | 2.86 | 1 | 5 | - | |
| 2. Intention to use the AIMHealth app | 3.03 | 1.15 | 3 | 1 | 5 | .19** | - |

$^{**}p < .01$.

## 3.2. Persuasive Messages: Manipulation test

To test the effects of the manipulation, one Mixed-Design ANOVA was conducted with the experimental conditions as a between-subjects factor with four levels (Societal Benefits [C1], Privacy Assurance [C2], Societal Benefits and Privacy Assurance [C3], and Informative [C4, control condition]) and each of the three manipulation check items (agreement of the participants with the content of the message as being focused on societal benefits, privacy assurance or only informative) as within-subjects variables. The Mixed-Design ANOVA results showed that there was a main effect of the type of message, $F$ (2 ,524) = 52.74, $p$ < .001, $\eta^2_p$ = 0.17. Moreover, there was also a significant interaction between the condition and the type of message, $F$ (6, 524) = 10.52, $p$ <.001, $\eta^2_p$ = 0.11. To further understand the interaction effect, we conducted planned comparisons.

The results showed that participants in the Societal Benefits condition (C1) agreed to a greater extent that the message they received was focused on Societal Benefits ($M$ = 5.37, $SD$ = 1.39), than focused on Privacy Assurance content ($M$ = 3.48, $SD$ = 1.87) or merely informative content ($M$ = 3.84, $SD$ = 1.69), $p$ < .001.

In the Privacy Assurance condition (C2), participants agreed to a greater extent that the message they received was focused on Privacy Assurance content ($M$ = 5.20, $SD$ = 1.46) than merely informative content (M = 3.43, SD = 1.57), $p$ < .001. However, there were no significant differences between the perception of the message as focusing on Privacy Assurance contents ($M$ = 5.20, $SD$ = 1.46) and Societal Benefits ($M$ = 4.78, $SD$ = 1.43).

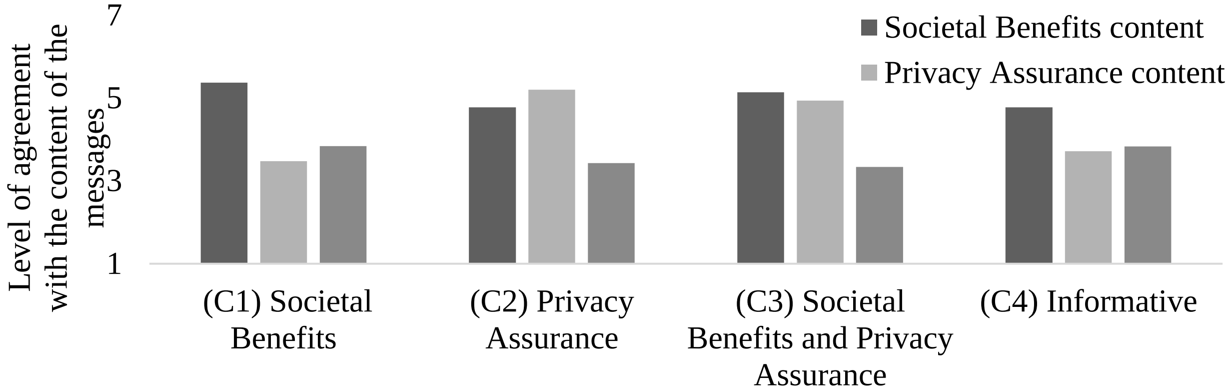
In the Societal Benefits and Privacy Assurance condition (C3), participants agreed to a similar extent that the message was focused on Societal Benefits ($M$ = 5.14, $SD$ = 1.36) and on Privacy Assurance ($M$ = 4.94, $SD$ = 1.66). These were both higher than the focus on informative content ($M$ = 3.43, $SD$ = 1.85), $p$ < .001.

In the Informative condition (C4) participants agreed to a greater extent that the message they received was focused on Societal Benefits ($M$ = 4.77, $SD$ = 1.71), than focused on informative content ($M$ = 3.83, $SD$ = 1.66, p = .029) or Privacy Assurance content ($M$ = 3.72, $SD$ = 1.81, p = .007).

Hence, the manipulation check indicated that participants did not perceive the message as intended in all conditions. See Figure 2 for a graphical representation of these results.

**Figure 2**

*Participants level of agreement with the content of the persuasive messages*



## 3.3. Relationship between sociodemographic variables and intention to use the app

The relationship between all sociodemographic variables and the dependent variable of the study, intention to use the AIMHealth application, were analysed. Only significant effects are presented.

An independent-sample t-test was performed, and we found a significant effect of gender on intention to use the AIMHealth app ($t$ (264) = - 2.38, $p$ = 0.018). Male participants were found to show lower intention to use the app ($M$ = 2.76, $SD$ = 1.22) than female participants ($M$ = 3.12, $SD$ =1.09).

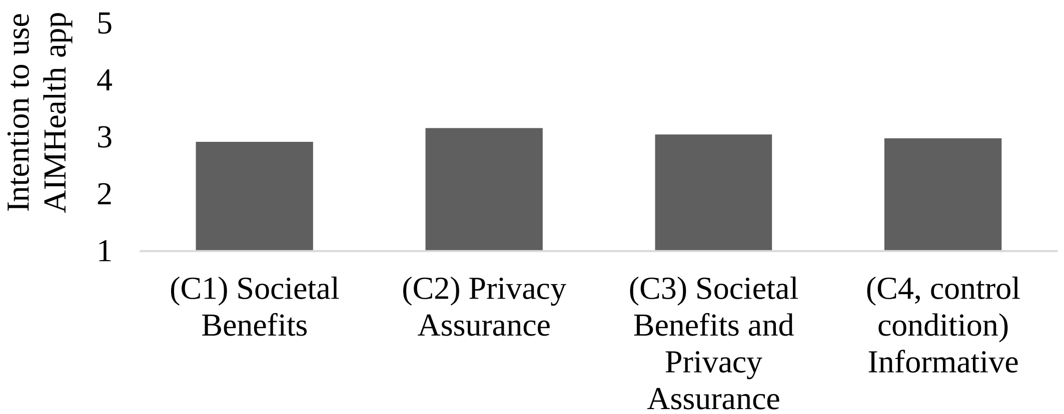
We also analysed whether the fact that participants had previously used a contact tracing app for COVID-19 was related to their intention to use the AIMHealth app. A significant effect of prior contact tracing application use on intention to use the AIMHealth application ($t$ (265) = 3.09, $p$ < 0.05). Participants who had never used a contact tracing application were less likely to intend to use the AIMHealth application ($M$ = 2.86, $SD$ =1.21) than those who had ($M$ = 3.30, $SD$ = 0.97). Given these findings, gender and prior use of contact tracing applications were used as control variables in all analyses presented below.

## 3.4. Effects of persuasive messages on intention to use the app

To compare the effects of the four different conditions on intention to use the AIMHealth app, a one-way ANOVA was conducted. Results showed no statistically significant differences between the different experimental conditions in terms of intention to use the AIMHealth app ($F$ (3,263) = .57, $p$ = .629). (Figure 3; See Appendix C for descriptive results). Results revealed a low intention to use the AIMHealth app ($M$ < 3.5).

**Figure 3**

*Persuasive Messages effect on Intention to use AIMHealth app*



## 3.5. Perceived COVID-19 Risk as a moderator of the relationship between persuasive messages and intention to use the app

The present model aims to assess whether the variable Perceived Risk of COVID-19 moderates the relationship between the experimental conditions (and the respective persuasive messages received) and the intention to use the AIMHealth application. This model was tested using the PROCESS macro model 1. The moderator variable was centered as its mean. Low and high levels of risk perception were considered as -1*SD* or +1*SD* above the mean. We created dummy variables in order to test for the effect of the experimental conditions. First, we used the informative condition (C4) as the reference group.

The linear model explained 12.2% ($R^2$=.122) of the variation in intention to use the AIMHealth application and it was significant (*F* (9, 256) = 3.96, *p* <.001).

First, it is important to mention that the COVID-19 Perceived risk was positively related with to the intention to use the AIMHealth app (*B* = 0.42, t = 2.38, *p* = .018).

There were no significant differences between the control condition (C4, informative) and the Societal Benefits condition (C1) on the intention to use the AIMHealth app (*B* = - 0.06, *t* = -.34, *p* = .737). There were no significant differences between the control condition (C4, informative) and the Privacy Assurance condition (C2) on the intention to use the AIMHealth app (*B* = 0.14, *t* = .68, *p* = .449). There were also no significant differences between the control condition (C4, informative) and the Societal Benefits *and* Privacy Assurance condition (C3) on the intention to use the AIMHealth app (*B* = - 0.03, *t* = -.14, *p* =. 891).

There was a significant difference in the effect of perceived risk on intention to use the AIMHealth app between the control condition (C4) and the Societal Benefits condition (C1) (*B* = -.67, *t* = -2.63, *p* = .009). This difference was not significant at a low level of the perceived risk of COVID-19 (-1*SD*) (*B* = 0.43, *t* = 1.62, *p* = .107), but it was significant at a higher level of perceived risk (+1*SD*) (*B* = - 0.56, *t* = -2.1, *p* =.038). At the highest level of the perceived risk of COVID-19, intention to use the AIMHealth application appears to be lower in the Societal Benefits condition (C1) than in the informative condition (C4).

There were no significant differences between the effect of perceived risk on intention to use the application between the control condition (C4) and the Privacy Assurance condition (C3) (*B* = - 0.06, *t* = -.24, *p* =.813), nor between the control condition (C4) and the Societal Benefits *and* Privacy Assurance condition (C3) (*B* = 0.05, *t* = .19, *p* =.849).

To better understand the differences between the experimental conditions, we repeated the model analysis, changing the reference group to obtain as many comparisons as possible. We present only the results not yet presented. With the Societal Benefits condition (C1) as the reference, there were no significant differences between the reference condition (C1, Societal Benefits) and the Privacy Assurance condition (C2) in terms of their effects on the intention to use the AIMHealth app (*B* = 0.20, *t* = 1.06, *p* =.292). There are also no significant differences between the reference condition (C1, Societal Benefits) and the Societal Benefits *and* Privacy Assurance condition (C3) in terms of their impact on the intention to use the AIMHealth app (*B* = .04, *t* = .19, *p* = .846).

There was a significant difference in the effect of perceived risk on intention to use the AIMHealth app between the reference condition (C1, Societal Benefits) and the Privacy Assurance condition (C2) (*B* =.61, *t* = 2.32, *p* =.021). This difference is not significant at a low level of the perceived risk of COVID-19 (-1DP) (*B* = - 0.25, *t* = -.87, *p* = .386), but it is significant at a higher level of perceived risk (+1SD) (*B* = 0.65, *t* = 2.48, *p* = .014). At the highest level of perceived risk (COVID-19), intention to use the AIMHealth application appears to be greater under the Privacy Assurance condition (C2) than in the Societal Benefits condition (C1).

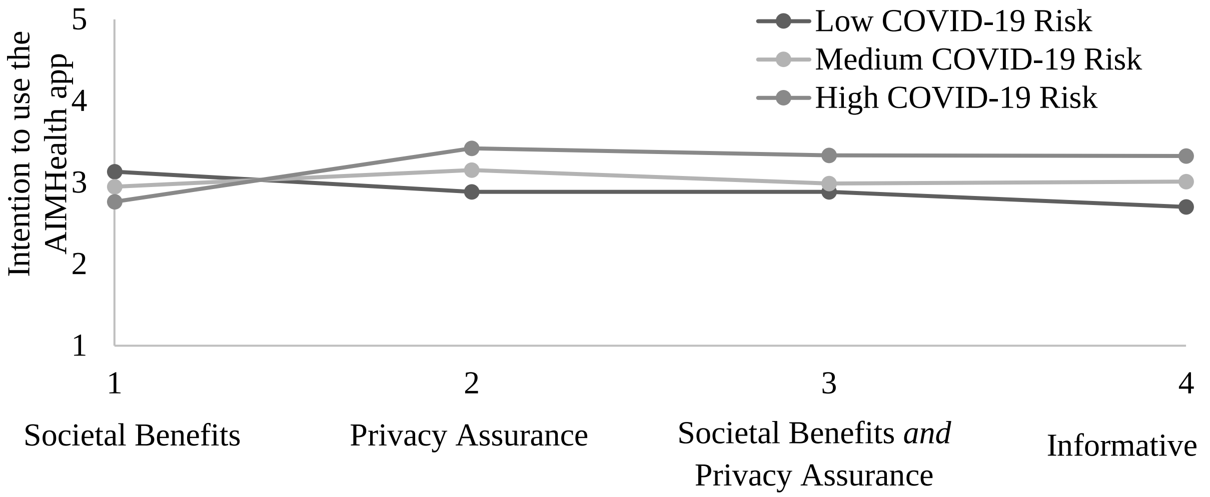
There was also a significant difference in the effect of perceived risk on intention to use the AIMHealth app between the reference condition (C1, Societal Benefits) and the Societal Benefits and Privacy Assurance condition (C3) (*B* = 0.72, *t* = 2.78, *p* = .006). It should be noted that this difference is not significant at a low level of the perceived risk of COVID-19 (-1*SD*) (*B* = - 0.50, *t* = -1.78, *p* = 0.076), but is significant at a higher level of perceived risk (+1*SD*) (*B* = 0.57, *t* = 2.11, *p* = .036). At the highest level of perceived risk (COVID-19), it appears that the intention to use the AIMHealth application is greater under the Societal Benefits and Privacy Assurance condition (C3) than under the Societal Benefits condition (C1).

Finally, Privacy Assurance (C2) was defined as the reference condition to compare with the Societal Benefits *and* Privacy Assurance condition (C3). There was no difference between the Privacy Assurance Condition (C2) and the Societal Benefits *and* Privacy Assurance condition (C3) on the intention to use the AIMHealth app (*B* = - 0.17, *t* = -.88, *p* = .382). Also, there are no significant differences of perceived risk on the intention to use the app between the Privacy Assurance (C2) condition and the Societal Benefits *and* Privacy Assurance condition (C3) (*B* = 0.11, *t* = .42, *p* =.675).

See Figure 4 for a visualization of the moderating effect and see appendix D to check the tables with the results of the regression for the moderation.

**Figure 4**

*Moderating effect of Perceived COVID-19 risk on the relationship between the persuasive messages and the intention to use the AIMHealth app*




### 3.6. Discussion of the quantitative findings

The aim of this part of the study was to understand how persuasive messages can influence the intention to use the AIMHealth app. The quantitative methods allowed us to compare the effect of the persuasive messages on the intention to use the AIMHealth app, and to understand if the COVID-19 Perceived Risk had a direct positive association with the intention to use the app. In addition, the present study also considered the role of COVID-19 perceived risk as a moderator of the relationship between persuasive messages and intention to use the AIMHealth app.

To check for the manipulation effects, we used three questions in which participants had to indicate the extent to which they agreed that the content of the message they read was focused on societal benefits, privacy assurance or just an informative content. These questions were designed to assess whether the experimental conditions matched their purpose and differed significantly from each other. However, the results showed not all the messages were perceived adequately by the participants. In fact, only the Societal Benefits condition (C1) and the Societal Benefits and Privacy Assurance condition (C3) were interpreted correctly by the participants, eliciting the correct attributes. The Privacy Assurance condition (C2) elicited both societal and privacy attributes and the Informative condition (C4) elicited societal attributes. Hence, the effects of the manipulations should be interpreted with caution.

Nevertheless, despite the manipulation check indicated that participants perceived different message attributes in the different conditions, the direct effect of the different persuasive messages on intention to use AIMHealth did not reach statistically significance. Our hypothesis

(H1) was that the societal benefit and privacy (C3) condition would lead to higher intention to use the app, as the persuasive message they received included both of the themes presented in the literature as important to users (societal benefit and privacy). However, these results were not confirmed.

Our second hypothesis (H2), that higher perceived risk for COVID-19 would be associated with a greater intention to use the application, was confirmed. This result is consistent with existing literature, specifically Guazzini et al. (2021), who showed that higher risk perception of COVID-19 was associated with higher adoption rates of contact tracing, and Li et al. (2021), who also found that COVID-19 risk perception was associated with intention to use a contact tracing app.

We then conducted moderation analysis to test whether the effect of persuasive messages on intention to use the app differed as a function of perceived risk level from COVID-19. We found that the perceived risk of COVID-19 plays a moderating role in this relationship, a result that partially confirmed Hypothesis 3. In fact, the effects of perceived risk did not occur in the expected direction.

Our results show that under the societal benefit condition (C1), there is a lower intention to use the application when the perceived risk of COVID-19 is higher, and a greater intention to use the application when the perceived risk is lower. In this case, part of our hypothesis 3 is confirmed, as perceived risk acts as a moderator. However, the second part of the hypothesis is rejected because the pattern by which moderation works is different than expected. Based on Riet et al. (2014) study we would expect that because the message conveyed in the Societal benefit condition (C1) was created in a gain-framed orientation, when the perceived COVID-19 was higher, the intention to use the application would be higher, because the gain-framed message should work better with individuals with higher perceived vulnerability.

Regarding the Privacy Assurance condition (C2) and Societal Benefits and Privacy Assurance condition (C3), the COVID-19 perceived risk also acts as a moderator between the conditions and the intention to use the application, however, the pattern of results is different from the Societal Benefits conditions (C1). For these two conditions (C2 and C3), the intention to use the application is higher when the perceived risk of COVID-19 is higher, and lower when the perceived risk of COVID-19 is lower. In this sense, Hypothesis 3 is confirmed regarding these two conditions, and going into accordance with Riet et al. (2014). These results suggest that the Privacy Assurance condition (C2) and Societal Benefits and Privacy Assurance condition (C3) worked better in the individuals with higher COVID-19 perceived risk, than the Societal Benefits condition (C1), which appear to work better in individuals with lower

COVID-19 perceived risks. This was unexpected since we expected all conditions to have higher intention to use the app, for high-risk individuals. Suggesting that tailoring message framing to the recipients' characteristics has the potential to maximize message persuasiveness.

One possible explanation is that the attribute Privacy Assurance is more crucial to high-risk individuals than the Societal Benefits attribute. In fact, although the Portuguese culture is less individualistic than the German culture (Hofstede, Hofstede & Minkov, 2010), it is also true that 60% of the Portuguese respondents indicate in representative surveys that they are not willing to share private data in digital means (European Commission, 2020). Some studies following the Privacy Paradox paradigm and conducted in the context of COVID-19, show that privacy is the highest priority for individuals, and they are unwilling to share personal information if the data is not secure, for example, in Bonner et al.'s (2020) study conducted in Germany and Switzerland, they echoed Trang et al.'s (2020) suggestion that there are different groups that share their beliefs about tracing apps: the advocates, the critics, and the undecided. However, their findings show that all groups acknowledge the benefits of COVID-19 apps and confirm that reservations about privacy are the biggest barrier to adoption. A large portion of the population in both countries were undecided about whether or not COVID-19 apps are a good or bad thing for society, given the threat posed by COVID-19.

In this context of our study, it is possible that privacy is more important than societal motives, especially if you are in the high-risk group and are therefore more likely to use the app. However, these results contradict a previous study also conducted in Portuguese reality. In fact, Fernandes and Costa's study showed a different pattern of results, in which they found that personal benefits and societal benefits were the most important predictors of sharing personal data with a contact tracing app, only then, followed by privacy concerns. Although, we need to consider that our design study differs from that of Fernandes and Costa (2021). First, their dependent variable in the study was disclosure related to contact tracking apps. They did not use an experimental design with persuasive messages, they focused on an existing app in Portugal, and their measurements were related to this app. In our case, we used persuasive messages in a simulated presentation of the app. It is possible that, faced with a hypothetical app with which they were not familiar, they preferred the message that guarantees privacy to the one that only promotes solidarity.

However, in their study, they also found that for young people, societal benefits were the most important predictor, while for people with a chronic illness, societal benefits and privacy concerns outweighed personal benefits. Regarding privacy concern, its influence on disclosure was not significant in young and healthy individuals. We can try to find some parallels between the study of Fernandes and Costa (2021) and our study. People with chronic diseases are likely to be more vulnerable and they are the ones who give more importance to privacy concerns, while young people, who are likely to be less vulnerable, give more importance to the societal aspects. These findings seem to follow the same pattern of the ones in our study. However, these are only assumptions because there are large differences between the two studies and the variables measured were not the same. Therefore, we cannot draw any real conclusions, but only say that these results need to be further studied so that we can better understand them.

CHAPTER 4

# Qualitative Results:

# Advantages and disadvantages of using the AIMHealth app

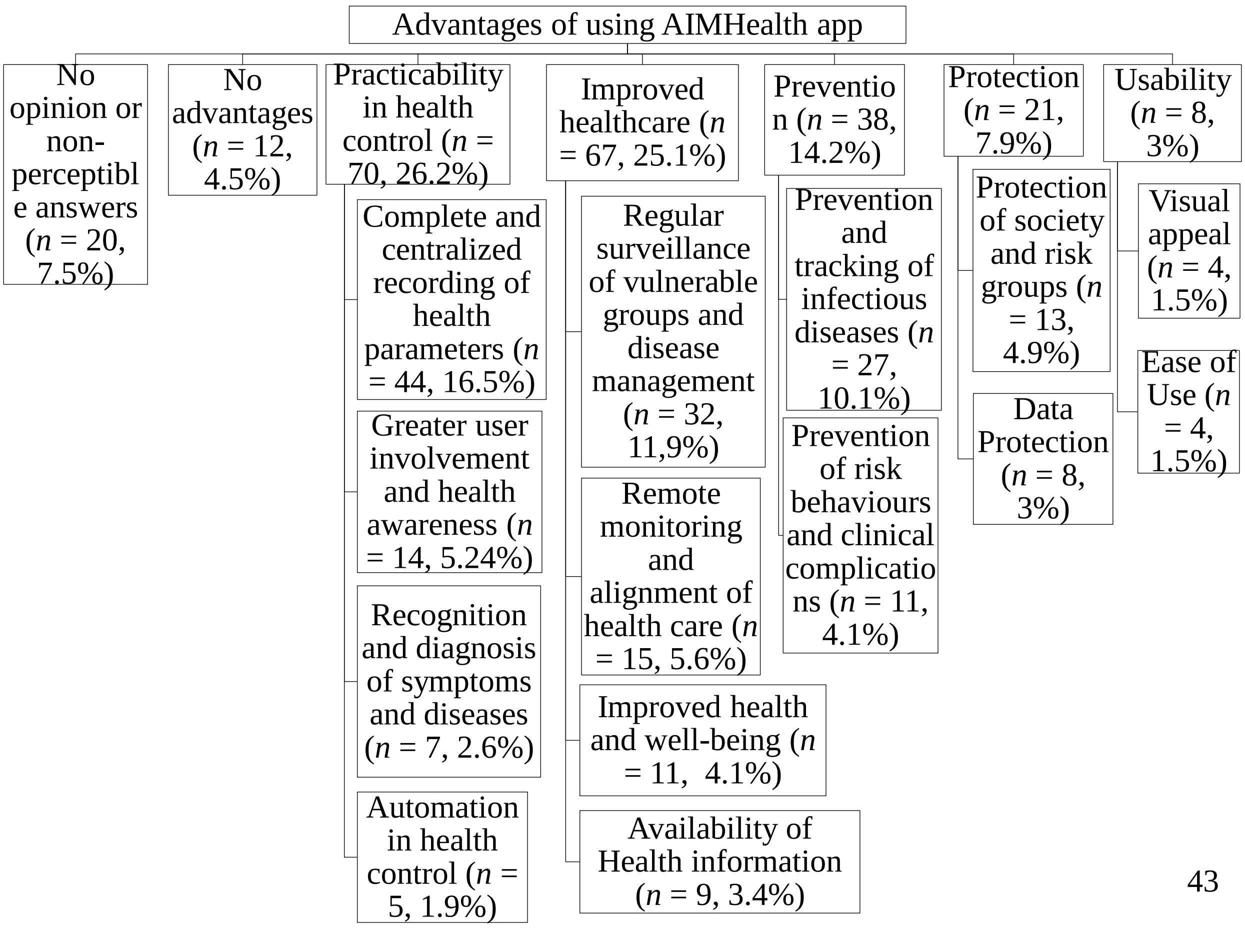
For the analyses of the open-ended questions, we first identified the most important issues related to the advantages and disadvantages of the AIMHealth app. We then examined differences as a function of experimental condition and risk perception from COVID-19 levels.

## 4.1. Thematic Analysis of the Advantages of using the AIMHealth app

Based on the thematic analysis of the open-ended responses provided by participants in the online questionnaire on the benefits of the AIMHealth application, seven main themes, and fourteen subthemes were identified, as you can see in Figure 6. It is important to note that not all 267 participants in this study responded to this open-ended question; only 198 participants did. Each participant had the freedom to name as many benefits as they wanted, so they could name more than one. The themes listed below were created through an inductive and descriptive thematic analysis of the participant's responses. It is important to note that the number of references in each theme and subtheme consists of the number of coded excerpts in each topic.

**Figure 5**

*Advantages of the AIMHealth app identified in the inductive thematic analysis*



#### 4.1.1. No advantages

This theme pertains to responses in which respondents indicate that they do not think there are any benefits to using the AIMHealth application (*n* = 12). e.g., "*I do not see any benefits*".

#### 4.1.2. No opinion or non-perceptible answer

This theme includes responses in which respondents expressed no opinion on the topic and responses in which it was not possible to understand what the participant meant (*n* = 20). e.g., "*I have no opinion*".

#### *4.1.3.* Practicability in health control

The most prevalent theme was the practicability of health monitoring (*n* = 70). This theme refers to the usefulness of the AIMHealth application in making the health check more practical and functional for the user. This theme includes the following subthemes: complete and centralized recording of health parameters; greater user involvement and health awareness; recognition and diagnosis of symptoms and diseases; and automation in health control.

The most prevalent subtopic was complete and centralized record of health parameters (*n* = 44). It was identified as a benefit of the AIMHealth app in the sense that using the app makes it easier to "*register different health parameters*" which can help to "*create a database about the users*" and ultimately be "*useful for health professionals to have a more complete record of the patient's condition over time*". In this sense, one of the most cited benefits of the AIMHealth app is "*the systemic registry of clinical information*", particularly by measuring "*features such as temperature and oxygen measurement that can be useful for everyone*" and that can be "*easily accessed on cell phones*".

Some participants suggested that the app could be "*very useful for patient follow-up allowing them to get to know themselves better and be more attentive*", leading to "*better knowledge about our health*" and "*greater personal control over health*" In this sense, the sub-theme greater user involvement and health awareness was identified (*n* = 14) and refers to the responses indicating that one of the benefits of the application is to enable greater user involvement by making it easy to become aware of and take control of one's health status.

Detection and diagnosis of symptoms and diseases (*n* = 7) was also identified as a sub-theme of practicability in health monitoring. This subtheme is seen as a benefit because it is related to the app allowing practice and "*quick detection of health problems*". Participants see the app as "*a home screening for citizens*", in the sense that "*tracking some parameters may* *help diagnostics and help according to the data provided*", which allows "*warning of serious health problems*".

The least common sub-theme of practicality in health control was automation in health monitoring (*n* = 5). This subtheme refers to responses in which participants indicated that a benefit of the app is "*automatic monitoring*" of health parameters, which allows for "*automatic tracking*" that can help by "*making essential human resources available for other tasks in the field of health" that cannot be automated*".

### 4.1.4. Improved healthcare

One of the themes identified was improved health care (*n* = 67). This theme was the second most frequently mentioned by participants. It includes responses in which participants mentioned features of the application that are considered benefits because they appear to facilitate access to health care. This theme includes the following subthemes: regular monitoring of vulnerable groups and disease management; remote monitoring and alignment of health care; availability of health information; and improved health and well-being.

The most prevalent subtopic was regular monitoring of vulnerable groups and disease management (*n* = 33). This subtheme refers to responses indicating that one of the benefits of the app is that it allows "*monitoring of patients from at-risk groups*" through "*frequent monitoring of health parameters for people with chronic diseases and who need to be well controlled*". The AIMHealth app is seen as "*especially beneficial for at-risk groups as it facilitates disease identification and follow-up of the disease*" and was mentioned as important in the specific case of dealing with the disease COVID-19 by "*monitoring the signs and symptoms of people infected with COVID 19, as well as vital signs, in order to understand when to go to the hospital or a health clinic. In a way, it will reassure people who are self-isolating at home*".

Remote monitoring and health care alignment (*n* = 15) also seem to be a benefit of the AIMHealth app, as the app allows for "*remote monitoring*" and this leads to "*better access to health care*", which seems to create "*closer care*" and better "*contact with health care services*". The fact that the app is "*connected with the physicians*" and allows its "*use by health care professionals in following patients*" through "*remote monitoring of health indicators*" seems to be a relevant benefit, so this was the second most common sub-theme on access to healthcare.

One of the ways the AIMHealth app appears to improve accessibility to health care is by improving health and well-being (*n* = 11). This was one of the identified subthemes based on participants' responses expressing that using the app could be good for "*the health and well-*

*being of the people*". The app appears to help "*improve their user's well-being*" by "*improving health conditions*" and "*being useful for general health*".

Availability of health information was also cited as a benefit of the AIMHealth app (*n* = 9). In this sense, "*availability of information*" and the fact that the application helps its users "*know more information*" and "*be informed*" were mentioned as suitable features of the app.

**4.1.5. Prevention**

The third most common theme related to the benefits of the AIMHealth app was prevention (*n* = 38) which was identified based on responses that referred to the AIMHealth app as a prevention tool. This theme includes two subthemes: prevention and tracking of infectious diseases; and prevention of risk behaviours and clinical complications.

The prevention and tracking of infectious diseases subtheme (*n* = 27) refer to the responses in which the AIMHealth app was identified as a screening and risk assessment tool for infectious diseases and thus was considered an application to prevent the spread of these diseases. Participants mentioned that the app "*will serve to prevent transmissible diseases*" Specific to the disease COVID-19, the app was identified as beneficial to "*help in the screening of the disease and warn people with other comorbidities who have been in contact with a person with Covid-19*" to "*keep the community more controlled at the level of cases*" and to "*prevent the spread of the virus in the most fragile populations*".

The second identified subtopic was the prevention of risky behaviours and clinical complications (*n* = 11). In this sense, the AIMHealth app was identified as a "*prevention tool in the community*" that can help "*prevent situations that put health at risk*", namely "*helping to avoid risky behaviour*" and "*prevent serious diseases*".

**4.1.6. Protection**

One of the themes that emerged from the data collected was that of protection (*n* = 21), and it was mentioned that the AIMHealth application was a helpful protection tool. This theme is divided into the protection of society and at-risk groups, and data protection.

The sub-theme of protecting society and at-risk groups (*n* = 13) was identified based on participants' responses highlighting that the AIMHealth application could be helpful in "*protect vulnerable*", especially by "*helping others, especially the most vulnerable and elderly people*". In this sense, it is mentioned that AIMHealth allows "*to protect everyone and in particular, those who may be at greater risk"*, which is "*very useful for society*" by promoting "*greater public safety*".

It was mentioned that AIMHealth apps protect their users' data. One of the participants said, "*I just feel like my data is protected*", and others stated that one of the benefits of the app was "*data protection*" or "*confidentiality and protection*". This sense of "*security in utilizing the app gives users more confidence when entering personal and/or health information*". These responses led to the identification of the data protection subtopic (*n* = 8).

#### 4.1.7. Usability

The least mentioned topic was usability (*n* = 8). Usability is a term that refers to the quality attribute used to evaluate how easy a system interface is to use. It is usually related to user satisfaction with the interface. This topic includes two subtopics: visual appeal and ease of use.

The visual appeal subtopic (*n* = 4) was identified based on responses in which the visual attractiveness of the AIMHealth app was cited as a benefit. Some participants said that the app has a "*user-friendly visual aspect*" and is "*visually appealing*" or "*attractive*".

The ease-of-use subtopic (*n* = 4) was defined based on responses in which the AIMHealth app was described as "*easy to understand*" and "*easy to use*".

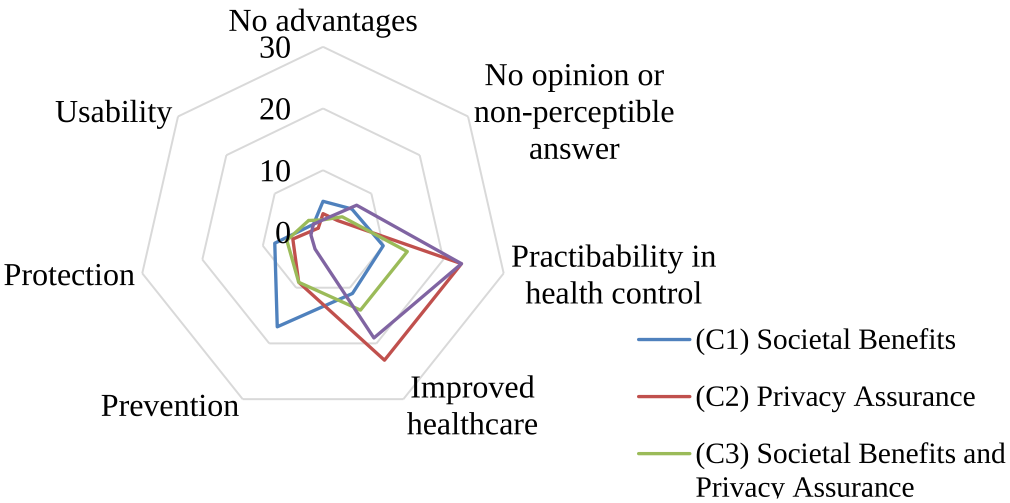
### 4.2. Analysis of the advantages of the AIMHealth app according to the participant's experimental condition

In the quantitative part of this study, we hypothesized that intention to use the AIMHealth app would vary depending on participants' experimental conditions, but these results were not confirmed. However, we thought that we could try to understand in an exploratory way whether in the open-ended questions about the app, participants' opinions about the app, in this case, the advantages perceived by participants, would differ depending on their experimental condition and the message received.

In figure 6 it is possible to see a visual illustration of the distribution of the advantages identified by the participants, according to their experimental conditions. In this illustration we can see that in the Societal Benefits condition (C1), the advantages that were most mentioned by these participants were related to the prevention feature of the AIMHealth app. In the Privacy Assurance (C2) and in the Informative (C4), the most mentioned advantages were the practicability of health control and the improved health care. In the Societal Benefits and Privacy Assurance condition (C3), although with a reduced frequency in mentioning the advantages, they also mentioned in higher degree the practicability in health control and the improved health care.

**Figure 6**

*Illustration of the advantages identified in the AIMHealth app according to participant's experimental condition*




In order to understand if the frequency of the advantages mentioned differed significantly between conditions, we decided to use the Chi-Square Goodness-of-Fit test, this test enables to test whether a categorical variable follows a specific distribution. It is important to note that these results need to be interpretated with caution, because not all the advantages' themes follow the assumptions, with some having less than 5 expected frequencies of advantages, impacting the results of the test. To conduct this test, we hypothesized that the distribution would be equal between conditions, which means that significant values means that there are differences between the conditions. In the majority of the themes of advantages identified, there were no differences between conditions, as can be seen in Table 4. However, in the prevention advantage, there is a significant result, that means that the frequency in which this advantage was referred differed between conditions, $X^2(3, 38) = 10.4$, $p = .015$. The Societal Benefits condition (C1) was the one where this advantage was most mentioned.

In the practicability in health control advantage, there is marginally significance, meaning that the frequency of identification of this advantage differed according to the participants condition, $X^2(3, 70) = 7.37$, $p = .061$, with the Privacy Assurance (C2) and the Informative (C4) condition, having the highest values. In the subcategories of the advantages, there were also significant values, these results are presented in the table 11, in the appendix E. In the protection of society and risk groups, the frequency that this advantage was mentioned differed between groups, $X^2$ $(3, 13) = 9.46$, $p = .024$. It was in the Societal Benefits condition (C1) that this advantage was mentioned the most. This result can be accessed in the full table of the advantages according to participants experimental condition in appendix E.

**Table 4**
*Summary of the main advantages according to participant's experimental condition*

| | C1 | C2 | C3 | C4 | $X^2$ | *p* |
|---|---|---|---|---|---|---|
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) | | |
| No advantages (*n* =12) | 5 (41.7) | 3 (25) | 2 (16.7) | 2 (16.7) | 2 | .572 |
| No opinion or non-perceptible answer (*n* = 20) | 6 (30) | 3 (15) | 4 (20) | 7 (35) | 2 | .572 |
| Practicability in health control (*n* = 70) | 10 (14.3) | 23 (32.9) | 14 (20) | 23 (32.9) | 7.37 | .061 |
| Improved healthcare (*n* = 67) | 11 (16.4) | 23 (34.3) | 14 (20.9) | 19 (28.4) | 5.06 | .167 |
| Prevention (*n* = 38) | 17 (44.7) | 9 (23.7) | 9 (23.7) | 3 (7.9) | 10.42 | .015 |
| Protection (*n* =21) | 8 (38.1) | 5 (23.8) | 6 (28.6) | 2 (9.5) | 3.57 | .312 |
| Usability (*n* = 8) | 2 (25) | 1 (12.5) | 3 (37.5) | 2 (25) | 1 | .801 |
| Total of Advantages (*n* =236) | 59 (25) | 67 (28.4) | 52 (22) | 58 (24.6) | 1.93 | .587 |

*Note.* *N* = 267. C1 (Societal Benefits), *n* = 62; C2 (Privacy Assurance), *n* = 69; C3 (Societal Benefits *and* Privacy Assurance), *n* = 65; C4 (Informative), *n* = 71.

## 4.3. Analysis of the advantages of the app according to the participants COVID-19 risk perception and experimental condition

Following the results of the quantitative analysis presented earlier, which identified the moderator role of COVID-19 risk perception in the relationship between persuasive messages and intention to use the AIMHealth app, we decided to further explore these findings in the qualitative responses. To do this, we sought to understand whether there was a difference between the benefits of using AIMHealth mentioned by participants, taking into consideration their COVID-19 risk perception and the experimental condition in which they were located.

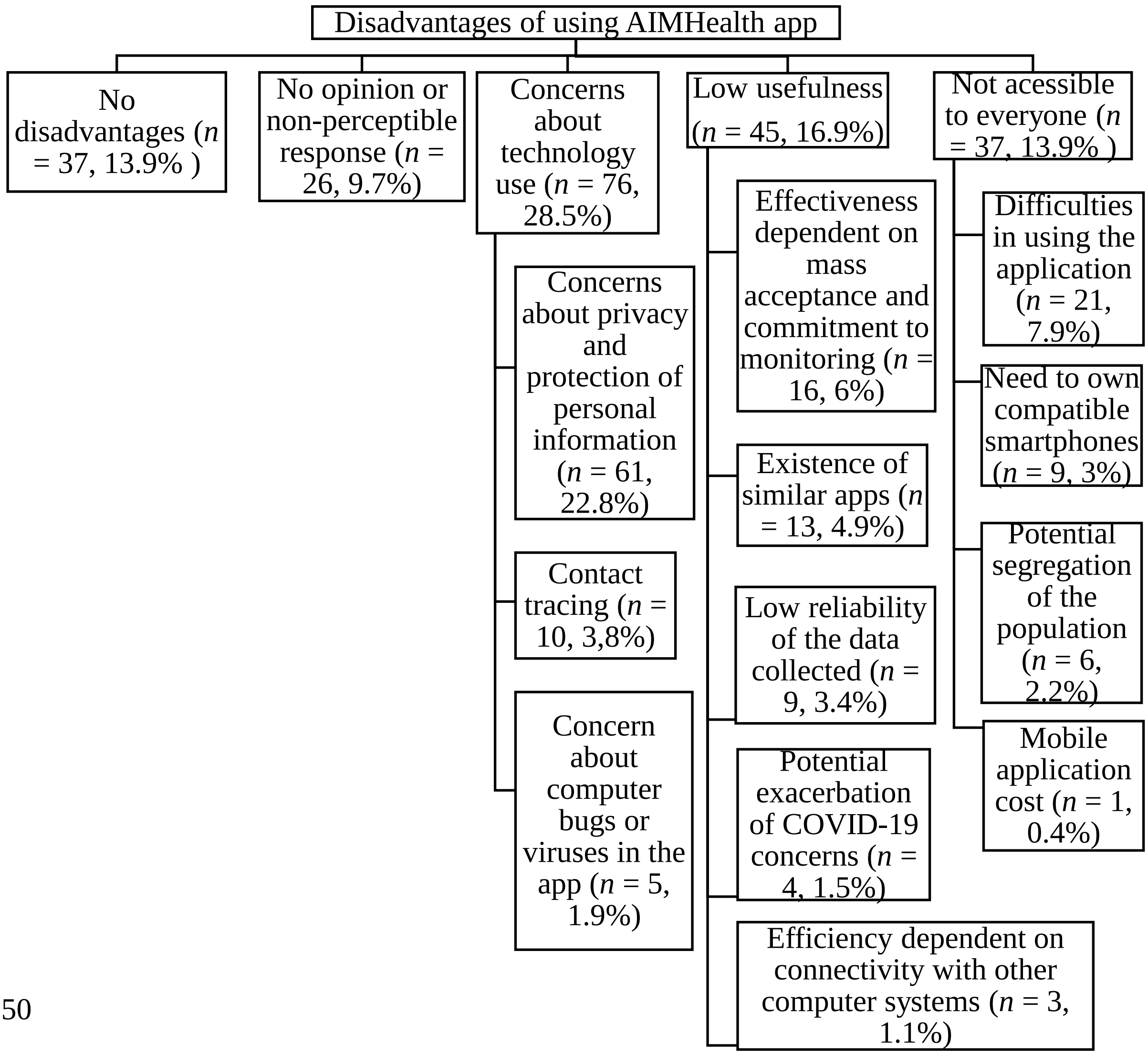
However, there do not seem to be any differences, so we do not find in this qualitative part of the study any confirmation of the results found in the quantitative part. Be that as it may, the tables from this analysis can be found in the Appendix F, for perusal. These tables show the frequency with which participants mentioned each topic and subtopic, whether they perceived a low, medium, or high COVID-19 risk, and whether they were in the Societal Benefits condition (C1), Privacy Assurance condition (C2), Societal Benefits *and* Privacy Assurance (C3), or Informative condition (C4). In this case the Chi-square test was not performed, because in some advantages the frequencies are really low, so test could not be performed, or would have results that could lack credibility. The greatest number of benefits were said by those in the medium level of perceived risk (n = 154), followed by those in the low-risk perception (n = 43) and then by those in the high-risk perception condition (n = 39).

## 4.4. Thematic Analysis of the Disadvantages of using the AIMHealth app

Based on the thematic analysis of the open-ended responses given by the participants in the online questionnaire on the disadvantages of using the AIMHealth application, five main themes, and twelve subthemes were identified, as you can see in Figure 7. It is important to note that not all 267 participants in this study responded to this open-ended question, only 188 participants did. Each participant had the freedom to name as many disadvantages as they wanted, so participants could name more than one. The themes listed below were created through an inductive and descriptive thematic analysis of the participant's responses. It is important to note that the number of references in each theme and subtheme consists of the number of coded excerpts in each topic.

**Figure 7**

*Disadvantages of the AIMHealth app identified in the inductive thematic analysis*



### 4.4.1. No disadvantages

This theme refers to responses in which respondents indicate that they believe there are no disadvantages to using the AIMHealth application (*n* = 37). e.g., "*Based on the information, I do not see any disadvantages*" and “*No disadvantages only came to help. Congratulations!*”.

### 4.4.2. No opinion or non-perceptible response

This theme includes responses in which the respondent expressed no opinion on the topic and responses in which it was impossible to discern what the participant meant (*n* = 26). e.g., "*I have no opinion*" Or "*I do not know*”.

### 4.4.3. Concerns about technology use

The theme with the highest prevalence was concern about technology use (*n* = 76). This theme was identified based on a group of responses that reiterated their concerns about using this type of technology precisely because it can compromise their privacy by tracking contacts or having viruses in the app. It includes three subthemes: concerns about privacy and protection of personal information; contact tracing; and concerns about computer bugs or viruses in the app.

The most prevalent subtopic is concern about privacy and protection of personal data (*n* = 61). This theme emerged in several responses that highlighted the participants' concerns about using the AIMHealth app because "*personal data must be shared",* and they do not know where it goes and what it is used for. Several participants said they "*lose control of my data*" and asked, "*where does my data go*?". There is a fear that it will be exposed and used for unauthorized purposes, "*as far as data protection, who guarantees that the data will not be used? You can always have a backdoor to register it and use it for sales*". It was mentioned that there is a "*risk of illicitly selling or sharing of data" and that data is "poorly managed*", fearing that "*for those who share information, their data is on who knows where in what servers and with what treatment* ".

Following these reflections, one of the identified concerns was contact tracing (*n* = 10), with participants mentioning that "*contact tracing*" is a drawback in itself and that they also "*think it is excessive to chase every infected person*", particularly in the case of the AIMHealth app, "*access to social media for risk detection*" or "*using social media to advise on testing*" seems to be a concern.

The least mentioned subtopic was concern about the presence of computer bugs or the subtopic (*n* = 5). It refers to the responses in which participants expressed concern about the presence of "*possible computer errors*" or "*technical errors*" in the application or even the occurrence of a "*virus or something similar*".

### 4.4.4. Low usefulness

The second most common theme was the low usefulness of AIMHealth (*n* = 45). This theme emerged from a group of responses indicating that participants did not think the AIMHealth app was helpful or useful. This theme includes five subthemes: effectiveness dependent on mass adoption and commitment to monitoring; the existence of similar apps; low reliability of data collected; potential exacerbation of COVID-19 concerns; and efficiency dependent on connectivity with other computer systems.

The most common subtheme related to low usefulness was effectiveness dependent on mass acceptance and commitment to monitoring (*n* = 16). Several participants indicated that there might be a "*lack of adherence*" particularly concerning features related to the disease COVID-19. They believe that there may be "*low adherence at a time when COVID is relatively controlled*" and that "*perhaps at an early stage of the spread of the disease it could have made more sense*" an app like this. In this sense, one drawback of the AIMHealth app is that it "*needs to have generalized adherence to it in order to be of any use*". Like other COVID-19 apps, they all need widespread adoption to be effective. Therefore, participants believe that "*if adherence is low, the benefit will not be great (as with STAYAWAY)*". It is also highlighted that the use of this app is hampered by "*the (lack of) practicality. In my personal experience, it is easy to lose interest in this type of application and forget about it*". In this sense, some participants mentioned that "*forgetting to enter data*" is likely to lead to "*lack of use*".

Another subtheme that emerged as a disadvantage of the AIMHealth app was the existence of similar apps (*n* = 13). Respondents felt that this app is just "*one more in what already exists*" and confirmed, "*I just cannot see any differentiators from other existing apps*". There is a feeling that the app is not very useful because "*it ends up being similar to other existing apps*" and because "*there are already apps for this*".

The sub-theme of low reliability (*n* = 9) also emerged in the analysis of responses. Some respondents emphasized that the disadvantage of the app was the distrust in the "*reliability of the records and the result thereof*". It is mentioned that "*for those who collect/receive information, it is dependent on the quality of the data entered, as they have little control over it*", with the possibility that "*if they enter incorrect health parameter data, it may lead to an incorrect diagnosis*", and that there is a need to consider the "*veracity of the users*".

Another subtopic identified was the potential for exacerbation of COVID-19 concerns (*n* = 4). Some participants indicated that they saw the possibility that the AIMHealth app could lead to "*the disease become even more "scary" for society*", because *"people will have to learn to live with COVID and this type of app will still the concern inherent to it remains very present*", with the opinion that "*the disadvantage of this app, in my opinion, could be related to a possible worsening of individuals' symptoms due to constant monitoring of symptoms (in the case of at-risk groups)*".

One of the subthemes that emerged was that the effectiveness of AIMHealth depends on connectivity with other computer systems (*n* = 3), with some participants confirming that "*the effectiveness/usefulness of this app depends on being well connected to other computer systems*".

#### 4.4.5. Not accessible to everyone

The least mentioned topic was the app not being accessible to everyone was (*n* = 37). The fact that participants believe the AIMHealth app is not accessible to everyone for various reasons was one of the disadvantages mentioned. This subtheme includes four subthemes: difficulties in using the application; need to own a compatible smartphone; potential segregation of the population; and mobile application cost.

Participants cited difficulties in using the application (*n* = 21) as a disadvantage of the AIMHealth app. Respondents indicated that "*some people may have difficulties in its utilization*", particularly the "*fact that an older people cannot use*" the app because it is not "*accessible to all age groups due to its online nature*". It is also mentioned that the app "*does not get to the info excluded ones*". In this sense, respondents seem concerned that the app might not be used by older people and people with lower e-literacy skills.

Some participants also mentioned the need to have a compatible smartphone as a problem (n = 9). They stated that "*not everyone has access to a mobile phone*" or that not everyone has "*a device that allows them to have the applicatio*n" because "*not all the population has access to mobile phones capable of supporting this app or similar*" apps.

One subtheme that emerged was potential population segregation (*n* = 6). This subtheme refers to the concern that people who do not use this app or similar apps may be excluded because they think they "*may be neglected in terms of personalized service, assistance, or intervention*" which could lead to "*potential segregation of people who do not use the similar app*".

The mobile app cost (n = 1) was also mentioned as a potential disadvantage of AIMHealth: "It's Price".

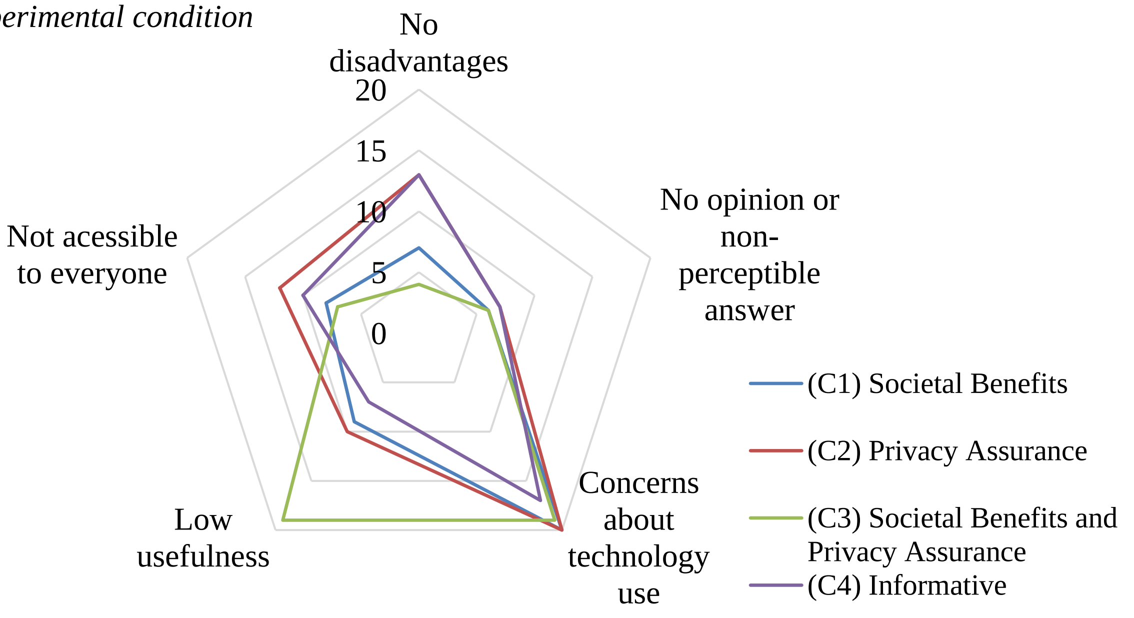
## 4.5. Analysis of the disadvantages of the AIMHealth app according to the participant's experimental condition

In the quantitative part of this study, we hypothesized that intention to use the AIMHealth app would vary depending on participants' experimental conditions, but these results were not confirmed. We thought that we could try to understand in an exploratory way whether in the open-ended questions about the app, participants' opinions about the app, in this case, the disadvantages perceived by participants, would differ depending on their experimental condition.

In figure 8 it is possible to see a visual illustration of the distribution of the disadvantages identified by the participants, according to their experimental conditions. In this illustration we can see that in the Societal Benefits condition (C1), the disadvantages most mentioned were related with the concerns about the technology use. In the Privacy Assurance (C2) and in the Informative (C4), the most mentioned disadvantages were also the concerns about the technology use, but in addition with the fact that the app might not be accessible to everyone. In the Societal Benefits and Privacy Assurance condition (C3) the two categories of disadvantages most mentioned were the low usefulness of the app and the concerns about technology use.

**Figure 8**

*Illustration of the disadvantages identified in the AIMHealth app according to participant's experimental condition*



In order to understand if the frequency of the disadvantages mentioned differed significantly between conditions, we decided to use the Chi-Square Goodness-of-Fit test, this test enables to test whether a categorical variable follows a specific distribution. It is important to note that these results need to be interpretated with caution, because not all the disadvantages' themes follow the assumptions, with some having less than 5 expected frequencies of disadvantages, which may impact the results of the test.

We hypothesized that the distribution would be equal between conditions, which means that significant values means that there are differences between the conditions. In the majority of the themes of disadvantages identified, there were no differences between conditions, as can be seen in Table 5 (full table can be accessed in the appendix G). However, in the low usefulness theme, there was a marginally significant result, meaning that the frequency in which this disadvantage was identified differed between the conditions, $X^2(3, 45) = [7.53]$, p = [.057], with the Societal Benefits and Privacy Assurance (C3), being the one with the highest frequency in mentioning this disadvantage.

**Table 5**

*Summary of the main disadvantages according to participant's experimental condition*

| | C1 | C2 | C3 | C4 | $X^2$ | *p* |
|---|---|---|---|---|---|---|
| | *n (%)* | *n (%)* | *n (%)* | *n (%)* | | |
| No disadvantages (n = 37) | 7 (18.9) | 13 (35.1) | 4 (10.8) | 13 (35.1) | 6.57 | .087 |
| No opinion or non-perceptible response (n = 26) | 6 (23.1) | 7 (18.9) | 6 (23.1) | 7 (18.9) | .15 | .985 |
| Concerns about technology use (n = 76) | 20 (26.3) | 20 (26.3) | 19 (25) | 17 (22.4) | .32 | .957 |
| Low usefulness (n = 45) | 9 (20) | 10 (22.2) | 19 (42.2) | 7 (15.5) | 7.53 | .057 |
| Not accessible to everyone (n = 37) | 8 (21.6) | 12 (32.4) | 7 (45.90) | 10 (27) | 1.6 | .661 |
| Total of Disadvantages (n = 221) | 50 (22.6) | 62 (28.1) | 55 (24.9) | 54 (24.4) | 1.35 | .717 |

*Note. N* = 270. C1 (Societal Benefits condition), *n* = 62; C2 (Privacy Assurance condition), *n* = 69; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 65; C4 (Informative condition), *n* = 71.

## 4.6 Analysis of the disadvantages of the AIMHealth app according to the participants COVID-19 risk perception and experimental condition

Following the results of the quantitative analysis presented earlier, which identified the moderator role of COVID-19 risk perception in the relationship between persuasive messages and intention to use the AIMHealth app, we decided to further explore these findings in the qualitative responses. To do this, we sought to understand whether there was a difference between the disadvantages of using AIMHealth mentioned by participants, taking into consideration their COVID-19 risk perception and the experimental condition in which they were located.

However, there do not seem to be any differences, so we do not find in this qualitative part of the study any confirmation of the results found in the quantitative part. Be that as it may, the full tables from this analysis can be found in the Appendix H, for perusal. These tables show the frequency with which participants mentioned each topic and subtopic, whether they perceived a low, medium, or high COVID-19 risk, and whether they were in the Societal Benefits condition (C1), Privacy Assurance condition (C2), Societal Benefits *and* Privacy Assurance (C3), or Informative condition (C4). In this case the Chi-square test was not performed, because in some disadvantages the frequencies are really low, so the test could not be performed, or would have results that could lack credibility. The greatest number of disadvantages were said by those in the medium level of COVID-19 perceived risk (n =133), followed by those with low-risk perception (n = 51), and then by those with high-risk perception (n = 37).

## 4.7. Discussion of the qualitative findings

To explore the opinions of the participants regarding the AIMHealth app, after presenting the manipulation, two open-ended questions were asked, one aimed at understanding what advantages they thought the app had, and another aimed at understanding what disadvantages they thought the app had. Responses to these questions were analysed using descriptive and inductive thematic analysis.

Regarding the advantages of the app mentioned by the participants, the thematic analysis demonstrated the existence of seven categories of advantages. Two categories referred to participants who did not have an opinion or did not have a perceptible answer and another for participants who stated that they did not see any advantage on the app. According to the most frequently mentioned category of advantages, the application was considered to make health control more practical. In this sense, the participants consider that the application helps essentially by providing a complete and centralized record of the health parameters of its users, leading to greater involvement and awareness of the users for their own health. In addition, the automation of health monitoring allows for better detection of symptoms and diseases. The second most frequently cited benefit was the fact that the application allows improved health care, through regular monitoring of at-risk groups and remote monitoring, which leads to a convergence of care, increasing health and well-being and also improving knowledge and availability of information about health.

According to the literature one of the most important predictors of a mobile health acceptance is its perceived usefulness, which is are a concept that is part of the two most studied models of technology acceptance, TAM and UTAUT. This concept refers to the extent to which individual's believe that the app will help them to manage their health. As mentioned in the literature review chapter, an app may be perceived as useful when it allows users to manage their health effectively or for example by giving users valuable information about their health (Venkatesh et al., 2013). In this sense, it is a good indicator that the two top categories of advantages that were identified of the AIMHealth are related to the usefulness of the app, because according to Deng et a. (2012), when patients perceive apps as useful for their health management, a positive attitude towards the app emerges and it leads to a positive behavioural intention to use it.

The application has also been referred as a tool to prevent diseases, especially infectious diseases, and to prevent clinical complication, and has also been considered as an application that protects society and risk groups, but also as an application that protects the data of its users. Loss of privacy has been identified as a significant factor on the acceptance of new technologies, if a user believes that their data is not secure, the adoption of these new technology initiatives will decrease (Calvo et al., 2020). Privacy concerns have posed a significant challenge for the adoption and use of COVID-19 contact tracing apps and are consistently cited in various studies as a factor that decreases intentions to use these apps (e.g., Sharma et al., 2020; Chan & Saqib, 2021). In this sense, it is good that the AIMHealth app was perceived as secure for some of the study participants.

Finally, there were also noted that one advantage of the app was in terms of its usability, describing it as visually appealing and seemingly easy to use. Perceived ease of use or effort expectancy are two constructs that capture the same concept and that are a part of the two most studied technology acceptance models, TAM and UTAUT. The concept captures the degree of ease associated with using the new technology in question. When users believe a health device is effortless to use, they expect better performance in managing their health and are more likely to adopt the device (Wang et al., 2020). In this sense, it is also a good indicator that the AIMHealth app was perceived as easy to use, because it could enhance its adoption.

Regarding the disadvantages of the application mentioned by the participants, the thematic analysis demonstrated the existence of three categories of disadvantages. The disadvantage most frequently mentioned by the participants was specifically related to the use of the technology, in the sense that they essentially stated that they were concerned about their privacy and the protection of their data. The participants specifically cited the fact that the app performs contact tracking as a reason for concern, and also mentioned that they were worried that the app contained bugs or viruses. Privacy concerns are critical in adopting mHealth services, as customers are uncertain about how providers behave and how their data is accessed and used (Guo et al., 2016). This is especially true for COVID-19 contact tracing apps, where reluctance to share personal health data due to privacy issues could jeopardize success (Fernandes & Costa, 2021). In this sense, it is not good the best indicator for the app acceptance that one of the most mentioned disadvantages was regarding to its security and privacy.

The second most frequently mentioned category of drawbacks was the low usefulness of the application. As mentioned above perceived usefulness is one of the most important predictors of the acceptance of these type of apps (Venkatesh et al., 2013), so the app being perceived as with lack of utility it is not a good indicator for its acceptance. Participants felt that the application was not useful. Mainly because in order to be useful, the application would have to be accepted and used by a large part of the population. On the other hand, in relation to the low usefulness, they also mentioned the fact that there are similar applications, that the data collected may not be very reliable, and that for the application to function optimally, it is necessary for it to be connected to other systems. Participants also mentioned that the features of the application related to COVID-19 may lead to an increase in concern about COVID-19 at a time when this concern should no longer exist. Finally, the third and last category of drawbacks relates to the fact that the application may not be accessible to everyone, with one of the main concerns being that it may be difficult for some people to use the app. On the other hand, users must also have a compatible cell phone to use the app. In this sense, a disadvantage highlighted is that the app may have a potential segregation and neglect effect in relation to people who do not use it. People who are not tech-savvy and who do not use smartphones and applications may not directly benefit from using a contact tracing application. Barriers to app use may be especially true for groups vulnerable to COVID-19, such as older people, but may also apply to other groups, such as children and groups that do not have the cognitive or physical abilities to use the app (Bradshaw et al., 2021). The survey responses indicate that further analysis is needed to facilitate the use of and access to the app, in order to increase the adoption of the app and reach a larger number of people, especially those in need.

Resuming, our results show that the participants of this study believe that the AIMHealth is especially beneficial in terms of practicality to health control and by permitting a higher accessibility to health care. However, participants also believe that the app might not be that useful, especially because it needs to be accepted by a large part of the population to be effective, and, at the same time, the app is not accessible to everyone, which might pose some difficulties when trying to reach its acceptance. The number of advantages and disadvantages identified in each condition its similar.

Based on the chi-square test, we found that the frequency that the following advantages were mentioned differed between conditions: prevention, practicability in health control, and protection of society and risk groups. In the Societal Benefits condition (C1) the prevention and the protection of society and risk groups were mentioned more times than in the other conditions, we believe that this result show some effect of the persuasive message that was received in this group, since these two advantages are essentially related with benefits to the society of using the app, since the prevention theme is related to the fact that the app might be a prevention tool to community, in preventing transmissible diseases from spreading and also, helping avoiding risky behaviours. And the protection of society and risk groups subtheme, enhance the app advantage of protecting vulnerable people and the society in general. Those two focus were transmitted in the Societal Benefits message. Regarding the practicability in health control, it was most mentioned by the participants in Privacy Assurance condition (C2) and in the Informative condition (C4), these two groups seemed to focus more on the technical and practical aspects of the app, by valuing more the actual usefulness of the app, instead of the benefits for the society, which also seems in accordance with the messages these groups received. It also focused more on the individual benefits of the app, which is also in line with Matt's (2021) study. In fact, in Matt's study, in the Privacy Assurance condition, the predictors of intention the intention to use the app, were especially the individual health advantages (not so much focused on gains to society).

The results of the open-ended questions reveal that the persuasive messages seemed to have the intended effect, although this was not captured entirely in the manipulation check measure. In fact, the results of the Societal Benefits condition (C1) are coherent both in the manipulation check question and in the open-ended responses. However, the results on the other conditions are not so straightforward. Nevertheless, although the Societal Benefits condition (C1) is the one where more promotion and prevention motives are spontaneously referred, they also refer more individual aspects such as practicability in health control. And this is true for all the persuasive messages, which shows that they tend to elicit similar constructs (although with different strength).

Some of the findings are difficult to explain given the theory in this domain. For instance, in the disadvantages the only difference found was in the theme of low usefulness, that was mostly mentioned by the Societal Benefits and Privacy Assurance (C3), these results are not according with what we expected, since we believed that this condition would be the condition with greater results. This is an unexpected result that requires further exploration in the future.

Regarding the qualitative analysis according to the experimental condition of the participants and their COVID-19 perceived risk, we did not test for the significance of the differences, because the values of each theme for condition and level where risk were low, so we could not perform this test. However, based on the observed frequencies, we believe that there are no differences between the conditions, according to the risk they are in, both in advantages and disadvantages, is in the medium risk that there is higher frequency of responses, which might be related to the fact that there are more participants that perceived a medium risk of COVID-19. In the low risk the participants mentioned more advantages than in the higher risk, but also perceived more disadvantages than in the higher risk. These results are not in accordance with what we expected, since we believed that in the different COVID-19 levels, there would be different advantages and disadvantages in each condition. It also does not reflect the findings in the quantitative results.

One explanation is that the order and mode of questions may have interfered with participant's responses. In fact, participants answered the open questions prior to the quantitative questions (e.g., intention to use the app). It may be possible that risk perception was only elicited when answering specific quantitative items and was not particularly salient in order to spontaneously refer advantages and disadvantages of the app. Recall that the mean level of risk perception is globally low in our sample and may be not sufficient to elicit strong involvement and responses to the open-ended questions.

CHAPTER 5

# General discussion

In this chapter, we will discuss all the results found in light of the theories and previous literature on the subject, in order to clarify the contribution of the present study to the existing literature. In addition, the limitations of the study will be discussed and possible suggestions for future studies will be presented.

The aim of this study was to contribute to the development of mobile applications adapted to users and their concerns by investigating how persuasive messages can influence the intention to use a COVID-19 mobile health app (AIMHealth app) and by examining users' opinions about this app. To this end, an online experimental study was developed using both quantitative and qualitative methods. Participants in the study were allocated into four conditions depending on the persuasive message they received: (C1) Societal Benefits, (C2) Privacy Assurance, (C3) Societal Benefits and Privacy Assurance, (C4, control condition) Informative. The quantitative methods allowed us to compare the effect of the persuasive messages on the intention to use the AIMHealth app. In addition, the present study also considered the role of COVID-19 perceived risk as a moderator of the relationship between persuasive messages and intention to use the AIMHealth app. We also used a qualitative method to capture participants' general opinions about the advantages and disadvantages of using the app.

As discussed before, our results did not find a direct effect of the persuasive messages on intention to use the AIMHealth app, however we did find a positive association of COVID-19 Perceived Risk with the intention to use the app, and also a moderator role of this variable on the relationship between the persuasive messages and the intention to use the AIMHealth app. Trying to further understand the differences between experimental conditions, in the qualitative part of the study we sought to examine if there were differences in the advantages and disadvantages mentioned by the participants, according to their experimental conditions. As presented before in some of the advantages themes and subthemes, and also in one disadvantage subtheme there were differences according to the condition the participants are in. These results seem to go in the opposite direction of the quantitative results; however, it is important to not forget that the variable measured in the quantitative part is the intention to use the app, and what is under analysis in the qualitative part is the participants opinion about the advantages and disadvantages of the app. One could think that according to the difference in the advantages and disadvantages there should be differences in the participants intention to use the app, however our results show that, the advantages and disadvantages mentioned by each condition may differ, but in general, in all conditions the quantity of advantages and disadvantages perceived are the same, which may explain why there are no differences in participants intention to use the app. Although in our study, we are reporting the qualitative advantages and disadvantages identified by the participants, in Matt's study, that was purely quantitative, they also found that, besides the intention to use the app was similar (did not have significant differences), the predictors (benefits or risks) of the app had different impact according to the participants' condition.

Based on the quantitative results, which showed that COVID-19 perceived risk moderated the association between persuasive messages and intention to use the AIMHealth app, we also sought to understand whether there were differences between the advantages and disadvantages cited by participants, considering their experimental conditions but also their perceived risk of covid-19. We had hoped that the pattern of results would be consistent with the quantitative results, but that was not the case. Both in the advantages and in the disadvantages analysis according to participants COVID-19 perceived risk, and according to their experimental conditions, we did not find differences. Which means that the qualitative results are not according to the quantitative part of the study, some possible explanations are related to the fact that a lower number of participants responded to the open-ended questions. But it is also important to reinforce, that as mentioned before, the variables in study are not the same, since in the quantitative part it was the intention to use the app and in the qualitative part the focus was on the advantages and disadvantages of the app.

However, one could think that the advantages and disadvantages perceived by the participants, would translate in their intention to use the app, so thinking the results in the quantitative part and the qualitative part would be similar. In this sense, we believe that some possible explanations to the differences between the analysis of the closed ended responses and the open ended responses could be related to the fact that in our sample, the general perception of COVID-19 risk is low and the study is about a mobile health application that has features that contribute to the spread of the virus, so it is possible that participants are not very interested in this topic. Web surveys offer new opportunities to obtain high-quality responses to open-ended questions because the interactive nature of the Internet allows questions to be tailored to individual respondents. Open-ended questions are important measures because they allow respondents to answer in their own words without being influenced by predetermined response categories. However, they require more effort than selecting from a list of options, so additional design features are often needed to improve the quality of responses (Holland & Christian, 2009). Krosnick (1999) states that respondents are often satisfied and provide an answer that meets the requirements of the question but do so with the least effort possible. Thus, because of the extra effort associated with open-ended questions, some individuals appear either unwilling to answer them or do not provide the high-quality responses most desired by survey respondents. Holland and Christian (2009) found that interest in the topic of a particular question influences respondents' decision to answer open-ended questions. In addition, interest affects the quality of responses in general, regardless of which version of the survey the respondent received. Those who show more interest consistently give significantly more topics and explain them significantly more often. They also usually give significantly more words. Thus, respondent interest in the topic is a strong predictor not only of respondents' decision to participate in a survey, but also of whether respondents choose to answer a particular question and of the quality of the answer given. In this sense, we believe that in our study, and because a smaller number of people also responded to the open-ended questions than to the closed-ended questions, the overall quality and time spent answering the open-ended questions may have influenced the results for these questions due to a possible low interest in the topic, such that the results were different than for the closed-ended questions.

Another possible explanation for these results is related to the fact that open-ended questions require more cognitive effort than closed-ended questions, regardless of participant interest. The closed-ended question requires less effort. Therefore, the likelihood of a non-response or a "do not know" response is lower. The open-ended question requires a significant amount of effort. The boundaries of the concepts being queried must be defined, then a memory search for instances of those concepts is initiated, and finally the answers can be generated. In closed-ended questions, the categories of interest are delineated by the response categories offered. The respondent has the simpler task of identifying a particular category (Vinten, 1995). We believe that in our study, because respondents had to answer the open-ended questions first, they had to "remember," i.e., use their memory to produce a specific answer, so that their answers about the pros and cons of the app were based on their initial thoughts about it without being stimulated by the answer choices. However, for the closed-ended questions and because the questionnaire they answered included several measures (some not presented in this study, such as perceived confidence in the app), recognizing and thinking about different aspects of the app may have influenced their responses.

Taking into account all the results of our study, it is a fact that we did not find a direct effect of the persuasive messages on the intention to use the AIMHealth app. We did find that regarding the participants condition they perceived in different extent different advantages and disadvantages, however in general, they perceived the same number of advantages and disadvantages. These results are in accordance with Matt's study (2021).

COVID-19 perceived risk is not only directly positively associated with the intention to use the app, which is in accordance with previous studies, (e.g., Guazzini et al., 2021)., as it is also a moderator of the relation between the persuasive messages and intention to use the app, which is also in accordance with what we expected based on the literature about the moderators of attribute framing (e.g. Riet et al., 2014). In this case, the qualitative part of the study did not find similar results. What seems important to retain, is that for high-risk individuals, privacy aspects were the most important, because only assuring the societal benefits of the app did not seem to work so well. We consider that these results should be better investigated in the future to fully understand them. However, it is important to note that overall privacy aspects sems to be important, even when not considering the high or low risk of the participants, first because although there were not significant differences between conditions, in the Privacy Assurance condition (C2) and in the Societal Benefits and Privacy Assurance condition (C3) there were higher mean of intention to use the app, and because, the most mentioned topic by the participants was their concern about the technology use (n = 76), especially, concerns about privacy and protection of personal data (n =61). These results are in accordance with the literature that has been repeatedly showing how the privacy concerns can reduce intention to use these intentions (e.g., Sharma et al., 2020), since when we assure privacy, the intentions are higher.

## 5.1. Limitations and future suggestions

The present study has some limitations that must be taken into account and can be considered in future research.

First of all, it is important to mention that the sample size, although acceptable, was not obtained by random sampling. The sample consists mainly of young people who have high academic qualifications, are female, healthy, and perceive a low risk in relation to the disease COVID-19. In addition, the recruitment process for this study was largely conducted through social media. Because of the online nature of the survey, which assumes access to and familiarity with computer and mobile technologies, study participants are exclusively computer-savvy individuals, which may have led to an oversaturation of self-selecting, technology-savvy individuals. In this sense, this is a convenience sample that is somewhat unbalanced, making it difficult to generalize the results. Therefore, the results of this study should not be generalized to other populations. For future studies, it would be important to use a representative population sample that would allow for generalization, especially because the only two Portuguese studies we found (Nunes et al. 2019; Fernandes & Costa, 2021), also used convenience samples.

It is also important to mention that this study was made regarding a specific application, that as features not only for COVID-19 detection, but also, other features to monitor the patient's health. These characteristics make this app very unique, which also makes it difficult to generalize the results of this study to other studies of mobile health apps acceptance. Also, taking into consideration the fact that this app has a focus on COVID-19, and in consequence this study also has, it is important to refer that the time and circumstances under which this study was made, are most surely not happening again, making it impossible to replicate it. In future studies of mobile health acceptance, the factors mentioned above should be taken into consideration.

Another relevant limitation it is related to the fact that the manipulation did not work as we expected in all of the conditions, which makes it difficult to interpret the results, and reach to conclusions with them. We believe that in future studies with this type of design, it is really important to guarantee that the manipulation works, so that the results can be more reliable.

As Matt (2021) stated in his study, he focused on comparing the most prevalent persuasive campaign themes used in the introduction of Covid-19 tracking apps and compared their effects. Thus, he suggested that in other studies, in addition to highlighting societal benefits or privacy, other foci might be plausible, such as a combination of different features and their possible elicitation of other effects. In our study, we differed from Matt by adding a control condition and combining the social benefit and privacy condition. However, it is important to understand if there are different aspects of these apps that could lead to different outcomes in their intent, so we also believe that other characteristics should be explored in future studies.

## 5.2. Conclusion

Considering the lack of literature on the acceptance of mobile health applications, namely COVID-19 applications, in Portugal, the present study aimed to contribute to this gap in the literature. Using an experimental design in which persuasive messages were used, this study aimed to promote the adoption of the AIMHealth application by trying to understand the best form of communication to achieve this.

We showed that the way messages are presented leads people to consider different attributes when adopting the app, without changing the details of the app itself.

In this sense, although our results are not generalizable to other apps, they suggest that it is necessary to pay attention to the target audience of the same when promoting this type of app. Since in our study the different arguments had different effects depending on the individual's perception of the individual in relation to COVID-19, we think that the perception of risk or vulnerability in relation to the health of the individual could be a factor that should be taken into account in the dissemination of this type of apps. In particular, our study shows the importance of telling users that their privacy is guaranteed. However, it is important to make sure that this privacy is indeed guaranteed.

The acceptance and use of these applications might be useful, outside of a pandemic situation, by allowing users to monitor their health, however, they might be especially useful to prevent the spread of transmissible diseases.

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# Appendix A
# Questionnaire

**Consentimento Informado**
O presente estudo, inserido no âmbito do projeto AIM Health, liderado pelo Centro de Investigação em Ciências da Informação, Tecnologias e Arquitetura (adiante designado ISTAR), tem por objetivo estudar a forma como a transmissão de informação pode influenciar a tomada de decisão na adoção de novas tecnologias, nomeadamente, da aplicação de saúde para telemóvel AIMHealth (adiante designada app AIMHealth).

Para participar neste estudo, **deverá ter 18 ou mais anos de idade** e preencher um questionário online, com uma duração aproximada de **10 minutos**, no qual pedimos que responda a algumas perguntas com a sua opinião acerca da app AIMHealth, que está a ser desenvolvida.

Este estudo é realizado pelo ISTAR, em colaboração com o Centro de Investigação e Intervenção Social (CIS), pela investigadora Matilde Cascalho (matilde_rafaela_cascalho@iscte-iul.pt), sob coordenação da Prof.ª Dr.ª Sibila Marques (sibila.marques@iscte-iul.pt), que poderá contactar caso deseje colocar alguma questão ou partilhar algum comentário.

A sua participação no estudo será muito valorizada, não se encontrando associado a esta nenhum risco significativo expectável. As suas respostas vão contribuir para o aumento do conhecimento sobre a adoção de aplicações de saúde, de forma a permitir o desenvolvimento de aplicações adaptadas aos utilizadores e às suas necessidades.

A participação neste estudo é estritamente **voluntária**: pode escolher participar ou não participar. Se escolher participar, pode interromper a participação, em qualquer momento, sem ter de prestar qualquer justificação. Para além de voluntária, a sua participação é **anónima** e **confidencial**, os dados recolhidos destinam-se apenas a tratamento estatístico, sendo que nenhuma resposta será analisada ou reportada individualmente. Em nenhum momento do estudo terá de se identificar.

Face a estas informações, por favor indique se aceita participar no estudo e clique no botão no canto inferior direito da página para avançar para a página seguinte. O preenchimento do questionário presume que compreendeu e que aceita as condições do presente estudo, consentindo participar.

- ◯ Aceito
- ◯ Não Aceito

**Questões Sociodemográficas**

Qual é a sua idade?

______________________________________________

Com que categoria se identifica?

- ◯ Masculino
- ◯ Feminino
- ◯ Outro

Qual o seu estado civil?

- ◯ Solteiro(a)
- ◯ União de Facto
- ◯ Casado(a)
- ◯ Separado(a
- ◯ Divorciado(a)
- ◯ Viúvo(a)

Q5 Habilitações Literárias

- ◯ 1º Ciclo (1º-4º ano)
- ◯ 2º Ciclo (5º-6º ano)
- ◯ 3º Ciclo (7º-9º ano)
- ◯ Ensino Secundário (10º-12º ano)
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento

Qual a sua situação profissional?

- ◯ Empregado(a)
- ◯ Desempregado(a)
- ◯ Estudante
- ◯ Trabalhador(a)-estudante
- ◯ Outro ________________________________________________

Caso tenha alguma doença diagnosticada por um médico, por favor indique qual ou quais:

- ☐ Hipertensão arterial (tensão alta)
- ☐ Diabetes
- ☐ Obesidade
- ☐ Cancro
- ☐ Doença cardiovascular (problemas cardíacos, ter sofrido um AVC, ...). Por favor, indique qual: ____________________________________________
- ☐ Doença respiratória (asma, doença pulmonar obstrutiva crónica, ...). Por favor, indique qual: ____________________________________________
- ☐ Doença autoimune (lupus, Sjögren, doença de Crohn, ...). Por favor, indique qual: ____________________________________________
- ☐ Doença neurológica (esclerose múltipla, doença de Parkinson, ...). Por favor, indique qual: ____________________________________________
- ☐ Doença mental (depressão, ansiedade crónica, ...). Por favor, indique qual: ____________________________________________
- ☐ Outra. Por favor, indique qual: ____________________________________________
- ☐ Nenhuma

**Questões sobre a situação face à COVID-19:**

Qual a sua situação face à doença COVID-19?

- ○ Não estou nem estive infetado(a)
- ○ Em quarentena ou vigilância ativa das autoridades de saúde (contacto com caso positivo)
- ○ Em isolamento ou confinamento obrigatório (diagnóstico confirmado)
- ○ Recuperado(a)

Teve contacto ou deu apoio a pessoas doentes com COVID-19?

- ○ Sim
- ○ Não
- ○ Não tenho a certeza

Teve familiares próximos doentes com COVID-19?

- ☐ Não
- ☐ Sim, com isolamento domiciliar
- ☐ Sim, com isolamento hospitalar
- ☐ Sim, com internamento nos cuidados intensivos

Por favor, leia cada uma das afirmações a seguir e escolha a resposta que melhor o(a) descreve.

| | 1. Negligenciável/Muito Pouco | 2. | 3. | 4. | 5. Muito/Muito Grande |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1. Qual considera que é a probabilidade de contrair COVID-19? | ○ | ○ | ○ | ○ | ○ |
| 2. Qual considera que é a probabilidade de contrair COVID-19 em comparação com outras pessoas? | ○ | ○ | ○ | ○ | ○ |
| 3. Qual considera que é a probabilidade de contrair outras doenças (por exemplo, diabetes/asma)? | ○ | ○ | ○ | ○ | ○ |
| 4. Qual considera que é a probabilidade de morrer devido ao COVID-19? | ○ | ○ | ○ | ○ | ○ |
| 5. Quão preocupado está com a possibilidade de contrair COVID-19? | ○ | ○ | ○ | ○ | ○ |
| 6. Quão preocupado está com o facto de um familiar contrair COVID-19? | ○ | ○ | ○ | ○ | ○ |
| 7. Quão preocupado está com a ocorrência de COVID-19 na sua região? | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| 8. Quão preocupado está com o facto do COVID-19 emergir como um problema de saúde? | ○ | ○ | ○ | ○ | ○ |

Como meio de combate à pandemia da COVID-19, em todo o mundo, foram desenvolvidas aplicações para telemóvel (apps), com o objetivo de rastrear os contactos das pessoas com diagnóstico de COVID-19. Já tinha tido conhecimento da existência deste tipo de aplicações?

- ○ Sim
- ○ Não

Assinale, na seguinte lista, as aplicações de rastreamento de contactos de pessoas com diagnóstico de COVID-19 que já tenha ouvido falar:

- ☐ STAYAWAY COVID
- ☐ Radar Covid
- ☐ Pingdemic
- ☐ Coronavírus - SUS
- ☐ Outra. Qual? ____________________________________________
- ☐ Não conheço nenhuma

Já utilizou alguma das aplicações referidas anteriormente ou outra aplicação parecida?

- ◯ Sim
- ◯ Não

Pensando, no geral, em aplicações de rastreamento de contactos, indique o seu grau de concordância com as seguintes afirmações:

| | Discordo totalmente | Discordo parcialmente | Nem concordo nem discordo | Concordo parcialmente | Concordo totalmente |
|---|---|---|---|---|---|
| 1. Utilizar uma aplicação de rastreamento de contactos parece-me uma boa ideia. | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2. Se tiver acesso a uma aplicação de rastreamento de contactos tenho intenção de a utilizar. | ◯ | ◯ | ◯ | ◯ | ◯ |
| 3. Eu gosto da ideia de vir a utilizar uma aplicação de rastreamento de contactos. | ◯ | ◯ | ◯ | ◯ | ◯ |
| 4. Penso que no futuro poderei utilizar uma aplicação de rastreamento de contactos regularmente. | ◯ | ◯ | ◯ | ◯ | ◯ |
| 5. Utilizar uma aplicação de rastreamento de contactos | ◯ | ◯ | ◯ | ◯ | ◯ |

| | | | | | |
|---|---|---|---|---|---|
| parece-me uma ideia acertada. | | | | | |
| 6. Caso seja disponibilizada, tenciono utilizar uma aplicação de rastreamento de contactos no futuro. | ○ | ○ | ○ | ○ | ○ |
| 7. Utilizar uma aplicação de rastreamento de contactos poderá ser útil. | ○ | ○ | ○ | ○ | ○ |
| 8. Supondo que tenho acesso a uma aplicação de rastreamento de contactos eu irei utilizá-la. | ○ | ○ | ○ | ○ | ○ |

**Descrição da AIMHealth de acordo com as diferentes condições em estudo.**
**Questões acerca da mensagem recebida e acerca da aplicação:**

| | Discordo totalmente | Discordo | Discordo parcialmente | Nem concordo nem discordo | Concordo parcialmente | Concordo | Concordo totalmente |
|---|---|---|---|---|---|---|---|
| 1. A mensagem transmitida acerca da app AIMHealth apresenta um foco na solidariedade/bem maior para a sociedade. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. A mensagem transmitida acerca da app AIMHealth apresenta um | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| foco na privacidade/proteção de dados. | | | | | | | |
| 3. A mensagem transmitida acerca da app AIMHealth não se foca em nenhuma das opções anteriores, apresenta informações gerais sobre o funcionamento da app. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. A mensagem transmitida acerca da app AIMHealth apresenta um foco **em: (preencha o espaço em branco** se considerar que a mensagem tem **outro** foco que não se encontra nas opções dadas) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Q17 Tendo em conta a informação disponibilizada acerca da app AIMHealth, quais considera ser as vantagens desta app?

________________________________________________________________

Q18 Tendo em conta a informação disponibilizada acerca da app AIMHealth, quais considera ser as desvantagens desta app?

________________________________________________________________

Q19 No seguimento das informações apresentadas acerca da app AIMHealth, indique qual o seu grau de concordância com cada uma das seguintes afirmações:

| | Discordo totalmente | Discordo parcialmente | Nem concordo nem discordo | Concordo parcialmente | Concordo totalmente |
|---|---|---|---|---|---|
| 1. Obter a app AIMHealth pode ajudar a manter-me saudável no futuro. | ○ | ○ | ○ | ○ | ○ |
| 2. Partilhar os meus dados na app AIMHeatlh poderá ajudar a sociedade em geral. | ○ | ○ | ○ | ○ | ○ |
| 3. Eu considero que o meu interesse pessoal na app AIMHealth ultrapassa a minha preocupação com possíveis riscos em relação à minha privacidade. | ○ | ○ | ○ | ○ | ○ |
| 4. Pessoas que me influenciam pensam que eu devo utilizar uma app como a AIMHealth. | ○ | ○ | ○ | ○ | ○ |
| 5. A app AIMHealth parece-me uma plataforma segura para troca de informações pessoais. | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| 6. Utilizar a app AIMHealth parece-me uma boa ideia. | ○ | ○ | ○ | ○ | ○ |
| 7. Se tiver acesso à app AIMHealth tenho intenção de a utilizar. | ○ | ○ | ○ | ○ | ○ |
| 8. Os benefícios para a saúde em obter a app AIMHealth ultrapassam os potenciais riscos. | ○ | ○ | ○ | ○ | ○ |
| 9. Os dados que poderei partilhar na app AIMHealth irão beneficiar a sociedade em geral. | ○ | ○ | ○ | ○ | ○ |
| 10. Quanto maior o meu interesse nos serviços da app AIMHealth, mais eu irei suprimir as minhas preocupações com a privacidade. | ○ | ○ | ○ | ○ | ○ |
| 11. Pessoas que são importantes para mim pensam que eu deveria utilizar uma app como a AIMHealth. | ○ | ○ | ○ | ○ | ○ |
| 12. A app AIMHealth parece-me uma plataforma de | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| confiança para o processamento de dados pessoais. | | | | | |
| 13. Eu gosto da ideia de vir a utilizar a app AIMHealth. | ○ | ○ | ○ | ○ | ○ |
| 14. Penso que no futuro poderei utilizar a app AIMHealth regularmente. | ○ | ○ | ○ | ○ | ○ |
| 15. Obter a app AIMHealth seria uma boa forma de proteger a minha saúde. | ○ | ○ | ○ | ○ | ○ |
| 16. Os dados que poderei partilhar na app AIMHealth são valiosos para a sociedade em geral. | ○ | ○ | ○ | ○ | ○ |
| 17. No geral, a minha necessidade de vir a utilizar app AIMHealth é maior do que a minha preocupação com a privacidade. | ○ | ○ | ○ | ○ | ○ |
| 18. Eu acredito que as pessoas na sociedade iriam querer que eu usasse a app AIMHealth. | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| 19. Acredito que a equipa de investigação do projeto AIMHealth tratará os dados pessoais submetidos na app AIMHealth de forma competente. | | | | | |
| 20. Utilizar a app AIMHealth parece-me uma ideia acertada. | | | | | |
| 21. Caso seja disponibilizada, tenciono utilizar a app AIMHealth no futuro. | | | | | |
| 22. Eu acredito que as pessoas na sociedade esperam que eu use uma app como a AIMHealth. | | | | | |
| 23. Utilizar a app AIMHealth poderá ser útil. | | | | | |
| 24. Supondo que tenho acesso à app AIMHealth eu irei utilizá-la. | | | | | |

# Appendix B
# Persuasive Messages

Below are the images and descriptions of the AIMHealth app that were presented to study participants according to condition. In each condition, a picture of the AIMHealth app and a description of the app were presented. The description of the app was the same in each condition; the difference was in the image presented. The Societal Benefits condition has already been presented in the Instruments, Measures, and Scales subsection of the Method section, so we present only the messages from the other conditions below.

## (C2) Privacy Assurance condition

Below you can see what was presented to the participants in the Privacy Assurance condition:

**Figure 9**

*Image presented to the participants in the Privacy Assurance condition*


Por favor, tome atenção ao texto e imagem que se encontram abaixo, iremos fazer perguntas sobre eles.

No âmbito do projeto AIMHealth, está a ser desenvolvida uma aplicação para monitorização de saúde utilizando o telemóvel (adiante designada app AIMHealth). A app AIMHealth visa servir dois propósitos diferentes:

1) Registar diversos parâmetros de saúde, como por exemplo, frequência cardíaca, saturação de oxigénio e temperatura corporal, permitindo o acompanhamento remoto de doentes de grupos de risco (ex.: diabéticos, hipertensos, com doença cardíaca, etc.…).

2) Estabelecer um diagnóstico COVID-19 e/ou acompanhar pacientes COVID-19 em ambulatório; através das redes sociais, esta aplicação também irá avaliar o risco de o utilizador ser infetado pelo vírus, com o objetivo de o aconselhar à realização de um teste COVID-19."

In this image it says: "This app was developed with a focus on protecting its users' data, following the principles of trust and transparency!".

In the description of the app (which is the same for each condition), the translation reads: "Please pay attention to the text and image below, we will ask you questions about it.

The AIMHealth project is developing a mobile health monitoring application (hereafter referred to as the AIMHealth app). The AIMHealth app will serve two different purposes:

1) Recording various health parameters such as heart rate, oxygen saturation, and body temperature to enable remote monitoring of patients from high-risk groups (e.g., diabetics, hypertensives, cardiac patients, etc.).

2) Making a COVID-19 diagnosis and/or following up on COVID-19 outpatients; via social networks, this application can also assess the user's risk of viral infection to advise him/her to perform a COVID-19 test."

## (C3) Societal Benefits *and* Privacy Assurance condition

Below is what was presented to participants in the Societal Benefits *and* Privacy Assurance condition:

**Figure 10**

*Image presented to the participants in the Societal Benefits and Privacy Assurance condition*


Por favor, tome atenção ao texto e imagem que se encontram abaixo, iremos fazer perguntas sobre eles.

No âmbito do projeto AIMHealth, está a ser desenvolvida uma aplicação para monitorização de saúde utilizando o telemóvel (adiante designada app AIMHealth). A app AIMHealth visa servir dois propósitos diferentes:

1) Registar diversos parâmetros de saúde, como por exemplo, frequência cardíaca, saturação de oxigénio e temperatura corporal, permitindo o acompanhamento remoto de doentes de grupos de risco (ex.: diabéticos, hipertensos, com doença cardíaca, etc.…).

2) Estabelecer um diagnóstico COVID-19 e/ou acompanhar pacientes COVID-19 em ambulatório; através das redes sociais, esta aplicação também irá avaliar o risco

de o utilizador ser infetado pelo vírus, com o objetivo de o aconselhar à realização de um teste COVID-19.”

In the image, it is written, "This app was developed with a focus on protecting its users' data, following the principles of trust and transparency. Using the app benefits everyone: your family, friends, and acquaintances, but especially the elderly and the most vulnerable!" The description text does not need to be translated here because, as mentioned above, it is the same for all conditions. So, the translation is above in the description of the message of Privacy Assurance.

## (C4, control condition) Informative

Below you can see what was presented to the participants in the Informative condition:

**Figure 11**

*Image presented to the participants in the Informative condition*


Por favor, tome atenção ao texto e imagem que se encontram abaixo, iremos fazer perguntas sobre eles.

No âmbito do projeto AIMHealth, está a ser desenvolvida uma aplicação para monitorização de saúde utilizando o telemóvel (adiante designada app AIMHealth). A app AIMHealth visa servir dois propósitos diferentes:

1) Registar diversos parâmetros de saúde, como por exemplo, frequência cardíaca, saturação de oxigénio e temperatura corporal, permitindo o acompanhamento remoto de doentes de grupos de risco (ex.: diabéticos, hipertensos, com doença cardíaca, etc.…).

2) Estabelecer um diagnóstico COVID-19 e/ou acompanhar pacientes COVID-19 em ambulatório; através das redes sociais, esta aplicação também irá avaliar o risco de o utilizador ser infetado pelo vírus, com o objetivo de o aconselhar à realização de um teste COVID-19.”

As you can see, the image in the control condition did not contain any message, but only showed the general aspect of the AIMHealth app when the app is opened. Participants in this condition only read the description of AIMHealth that was presented in all other conditions (the translation of the text can be found above in the description of the Privacy Assurance message).

# Appendix C
# Table with descriptive results of One-way ANOVA Analysis of Persuasive Messages effect on Intention to use AIMHealth app

**Table 6**

*One-way ANOVA Analysis of Persuasive Messages effect on Intention to use AIMHealth app*

| | C1 | | C2 | | C3 | | C4 | | *F* (3,262) | *p* | $\eta^2_p$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* | | | |
| Intention to use the AIMHealth app | 2.92 | 1.21 | 3.16 | 1.01 | 3.05 | 1.15 | 2.98 | 1.22 | .57 | .639 | .01 |

# Appendix D
# Tables with the regression results for Moderation

**Table 7**

Regression results for moderation with Informative as reference condition

| | | | | | $R^2$ |
|---|---|---|---|---|---|
| Outcome: Intention to use the AIMHealth app | | | | | .12 |
| | *B* | *SE* | *t* | *p* | |
| (C1) Societal Benefits | -.06 | .19 | -.34 | .737 | |
| (C2) Privacy Assurance | .14 | .19 | .76 | .449 | |
| (C3) Societal Benefits and Privacy Assurance | -.03 | .19 | -.14 | .891 | |
| COVID-19 Perceived Risk | .42 | .18 | 2.38 | .018 | |
| (C1) Societal Benefits x COVID-19 Perceived Risk | -.67 | .26 | -2.63 | .009 | |
| (C2) Privacy Assurance x COVID-19 Perceived Risk | -.06 | .26 | -.24 | .813 | |
| (C3) Societal Benefits and Privacy Assurance x COVID-19 Perceived Risk | .05 | .15 | .19 | .849 | |

Note. The reference condition is the Informative (C4, control condition).

**Table 8**

Regression results for moderation with Societal Benefits as reference condition

| | | | | | $R^2$ |
|---|---|---|---|---|---|
| Outcome: Intention to use the AIMHealth app | | | | | .12 |
| | *B* | *SE* | *t* | *p* | |
| (C2) Privacy Assurance | .20 | .19 | 1.06 | .292 | |
| (C3) Societal Benefits and Privacy Assurance | .04 | .19 | .19 | .846 | |
| (C4, control condition) Informative | -.06 | .19 | -.34 | .737 | |
| COVID-19 Perceived Risk | .42 | .18 | 2.38 | .018 | |
| (C2) Privacy Assurance x COVID-19 Perceived Risk | .61 | .26 | 2.32 | .021 | |
| (C3) Societal Benefits and Privacy Assurance x COVID-19 Perceived Risk | .72 | .26 | 2.78 | .005 | |
| (C4, control condition) x COVID-19 Perceived Risk | .67 | .26 | 2.63 | .009 | |

Note. The reference condition is the Societal Benefits condition.

**Table 9**

Regression results for moderation with Privacy Assurance as reference condition

| | | | | | $R^2$ |
|---|---|---|---|---|---|
| Outcome: Intention to use the AIMHealth app | | | | | .12 |
| | *B* | *SE* | *t* | *p* | |
| (C1) Societal Benefits | -.20 | .19 | -1.06 | .292 | |
| (C3) Societal Benefits and Privacy Assurance | -.17 | .19 | -.88 | .382 | |
| (C4, control condition) Informative | -.14 | .19 | -.76 | .449 | |
| COVID-19 Perceived Risk | .42 | .18 | 2.38 | .018 | |
| (C1) Societal Benefits x COVID-19 Perceived Risk | -.61 | .26 | -2.32 | .021 | |
| (C3) Societal Benefits and Privacy Assurance x COVID-19 Perceived Risk | .11 | .26 | .42 | .675 | |
| (C4, control condition) Informative x COVID-19 Perceived Risk | .06 | .26 | .24 | .813 | |

Note. The reference condition is the Privacy Assurance condition.

# Appendix E
# Table of the advantages depending on the participant's experimental condition

**Table 10**

*Advantages identified according to participant's experimental condition*

| | C1 | C2 | C3 | C4 | $X^2$ | *p* |
|---|---|---|---|---|---|---|
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) | | |
| No advantages (*n* = 12) | 5 (41.7) | 3 (25) | 2 (16.7) | 2 (16.7) | 2 | .572 |
| No opinion or non-perceptible answer (*n* = 20) | 6 (30) | 3 (15) | 4 (20) | 7 (35) | 2 | .572 |
| Practicability in health control (*n* = 70) | 10 (14.3) | 23 (32.9) | 14 (20) | 23 (32.9) | 7.37 | .061 |
| Complete and centralized recording of health parameters (*n* = 44) | 9 (20.5) | 15 (34.1) | 5 (11.4) | 15 (34.1) | 6.55 | .088 |
| Greater user involvement and health awareness (*n* = 14) | 1 (7.1) | 4 (28.6) | 4 (28.6) | 5 (35.7) | 2.57 | .463 |
| Recognition and diagnosis of symptoms and diseases (*n* = 7) | 0 | 2 (28.6) | 2 (28.6) | 3 (42.9) | .29 | .867 |
| Automation in health control (*n* = 5) | 0 | 2 (40) | 3 (60) | 0 | .20 | .655 |
| Improved Healthcare (*n* = 67) | 11 (16.4) | 23 (34.3) | 14 (20.9) | 19 (28.4) | 5.06 | .167 |
| Regular surveillance of vulnerable groups and disease management (*n* = 32) | 4 (12.5) | 11 (34.4) | 7 (21.9) | 10 (31.3) | 3.75 | .290 |
| Remote monitoring and alignment of health care (*n* = 15) | 2 (13.3) | 5 (33.3) | 4 (26.7) | 4 (26.7) | 1.27 | .737 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Improved health and well-being (*n* = 11) | 2 (18.2) | 4 (36.4) | 2 (18.2) | 3 (27.3) | 1 | .801 |
| Availability of Health Information (*n* = 9) | 3 (33.3) | 3 (33.3) | 1 (11.1) | 2 (22.2) | 1.22 | .748 |
| Prevention (*n* = 38) | 17 (44.7) | 9 (23.7) | 9 (23.7) | 3 (7.9) | 10.42 | .015 |
| Prevention and tracking of infectious diseases (e.g., COVID) (*n* = 27) | 11 (40.7) | 8 (29.6) | 6 (22.2) | 2 (7.4) | 6.33 | .096 |
| Prevention of risk behaviours and clinical complications (*n* = 11) | 6 (54.5) | 1 (9.1) | 3 (27.3) | 1 (9.1) | 6.09 | .107 |
| Protection (*n* = 21) | 8 (38.1) | 5 (23.8) | 6 (28.6) | 2 (9.5) | 3.57 | .312 |
| Protection of society and risk groups (*n* = 13) | 8 (61.5) | 2 (15.4) | 2 (15.4) | 1 (7.7) | 9.46 | .024 |
| Data Protection (*n* = 8) | 0 | 3 (37.5) | 4 (50) | 1 (12.5) | 1.75 | .417 |
| Usability (*n* = 8) | 2 (25) | 1 (12.5) | 3 (37.5) | 2 (25) | 1 | .801 |
| Visual appeal (*n* = 4) | 1 (25) | 0 | 2 (50) | 1 (25) | .50 | .779 |
| Ease of Use (*n* = 4) | 1 (25) | 1 (25) | 1 (25) | 1 (25) | 0 | 1 |
| Total of Advantages (*n* =236) | 59 (25) | 67 (28.4) | 52 (22) | 58 (24.6) | 1.93 | .587 |

*Note*. *N* = 267. C1 (Societal Benefits condition), *n* = 62; C2 (Privacy Assurance condition), *n* = 69; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 65; C4 (Informative condition), *n* = 71.

# Appendix F
# Table of the advantages depending on the participant's COVID-19 Perceived risk and experimental condition

**Table 11**

*Advantages identified by participants with low COVID-19 Perceived Risk according to their experimental condition*

| | Low COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No advantages (*n* =2) | 0 | 1 (50) | 0 | 1 (50) |
| No opinion or non-perceptible answer (*n* =5) | 1 (20) | 0 | 3 (60) | 1 (20) |
| Practicability in health control (*n* = 11) | 2 (18.2) | 3 (27.3) | 2 (18.2) | 4 (36.4) |
| Complete and centralized recording of health parameters (*n* = 5) | 1 (20) | 2 (40) | 0 | 2 (40) |
| Greater user involvement and health awareness (*n* =3) | 1 (33.3) | 0 | 1 (33.3) | 1 (33.3) |
| Recognition and diagnosis of symptoms and diseases (*n* = 1) | 0 | 0 | 0 | 1 (100) |
| Automation in health control (*n* = 2) | 0 | 1 (50) | 1 (50) | 0 |
| Improved healthcare (*n* = 17) | 4 (23.5) | 5 (29.4) | 4 (23.5) | 4 (23.5) |
| Regular surveillance of vulnerable groups and disease management (*n* = 7) | 2 (28.6) | 1 (14.3) | 3 (42.9) | 1 (14.3) |
| Remote monitoring and alignment of health care (*n* = 6) | 1 (16.7) | 2 (33.3) | 1 (16.7) | 2 (33.3) |
| Improved health and well-being (*n* = 2) | 0 | 1 (50) | 0 | 1 (50) |
| Availability of Health Information (*n* = 2) | 1 (50) | 1 (50) | 0 | 0 |
| Prevention (*n* = 6) | 3 (50) | 1 (16.7) | 2 (33.3) | 0 |
| Prevention and tracking of infectious diseases (e.g., COVID) (*n* = 4) | 1 (25) | 1 (25) | 2 (50) | 0 |
| Prevention of risk behaviours and clinical complications (*n* =2) | 2 (100) | 0 | 0 | 0 |
| Protection (*n* = 0) | 0 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Protection of society and risk groups (*n* = 0) | 0 | 0 | 0 | 0 |
| Data Protection (*n* = 0) | 0 | 0 | 0 | 0 |
| Usability (*n* = 2) | 1 (50) | 0 | 0 | 1 (50) |
| Visual appeal (*n* = 1) | 1 (100) | 0 | 0 | 0 |
| Ease of Use (*n* = 1) | 0 | 0 | 0 | 1 (100) |
| Total of Advantages (*n* = 43) | 11 (25.6) | 10 (23.3) | 11 (25.6) | 11 (25.6) |

*Note.* *N* = 267. C1 (Societal Benefits condition), *n* = 10; C2 (Privacy Assurance condition), *n* = 12; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 13; C4 (Informative condition), *n* = 14.

**Table 12**

*Advantages identified by participants with medium COVID-19 Perceived Risk according to their experimental condition*

| | Medium COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No advantages (*n* = 7) | 4 (57.1) | 0 | 2 (28.6) | 1 (14.3) |
| No opinion or non-perceptible answer (*n* = 11) | 3 (27.3) | 3 (27.3) | 1 (9.1) | 4 (36.4) |
| Practicability in health control (*n* = 49) | 8 (16.3) | 18 (36.7) | 8 (16.3) | 15 (30.6) |
| Complete and centralized recording of health parameters (*n* = 32) | 8 (25) | 11 (34.4) | 4 (12.5) | 9 (28.1) |
| Greater user involvement and health awareness (*n* = 10) | 0 | 4 (40) | 2 (20) | 4 (40) |
| Recognition and diagnosis of symptoms and diseases (*n* = 5) | 0 | 2 (40) | 1 (20) | 2 (40) |
| Automation in health control (*n* = 2) | 0 | 1 (50) | 1 (50) | 0 |
| Improved healthcare (*n* = 41) | 7 (17.1) | 14 (34.1) | 8 (19.5) | 12 (29.3) |
| Regular surveillance of vulnerable groups and disease management (*n* = 20) | 2 (10) | 8 (40) | 3 (15) | 7 (35) |
| Remote monitoring and alignment of health care (*n* = 8) | 1 (12.5) | 3 (37.5) | 3 (37.5) | 1 (12.5) |

| | | | | |
|---|---|---|---|---|
| Improved health and well-being (*n* = 8) | 2 (25) | 2 (25) | 2 (25) | 2 (25) |
| Availability of Health Information (*n* = 5) | 2 (40) | 1 (20) | 0 | 2 (40) |
| Prevention (*n* = 27) | 12 (44.4) | 7 (25.9) | 5 (18.5) | 3 (11.1) |
| Prevention and tracking of infectious diseases (e.g., COVID) (*n* = 19) | 8 (42.1) | 6 (31.6) | 3 (15.8) | 2 (10.5) |
| Prevention of risk behaviours and clinical complications (*n* = 8) | 4 (50) | 1 (12.5) | 2 (25) | 1 (12.5) |
| Protection (*n* = 14) | 6 (42.9) | 3 (21.4) | 3 (21.4) | 2 (14.3) |
| Protection of society and risk groups (*n* = 9) | 6 (66.7) | 1 (11.1) | 1 (11.1) | 1 (11.1) |
| Data Protection (*n* = 5) | 0 | 2 (40) | 2 (40) | 1 (20) |
| Usability (*n* = 5) | 0 | 1 (20) | 3 (60) | 1 (20) |
| Visually appealing (*n* = 3) | 0 | 0 | 2 (66.7) | 1 (33.3) |
| Ease of Use (*n* =2) | 0 | 1 (50) | 1 (50) | 0 |
| Total of Advantages (*n* = 154) | 40 (26) | 46 (30) | 30 (19.4) | 38 (24.6) |

*Note. N* = 267. C1 (Societal Benefits condition), *n* = 40; C2 (Privacy Assurance condition), *n* = 46; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 39; C4 (Informative condition), *n* = 46.

**Table 13**

*Advantages identified by participants with high COVID-19 Perceived Risk according to their experimental condition*

| | High COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No advantages (*n* = 3) | 1 (33.3) | 2 (66.7) | 0 | 0 |
| No opinion or non-perceptible answer (n = 4) | 2 (50) | 0 | 0 | 2 (50) |
| Practicability in health control (*n* = 10) | 0 | 2 (20) | 4 (40) | 4 (40) |
| Complete and centralized recording of health parameters (*n* = 7) | 0 | 2 (28.6) | 1 (14.3) | 4 (57.1) |
| Greater user involvement and health awareness (*n* = 1) | 0 | 0 | 1 (100) | 0 |

| | | | | |
|---|---|---|---|---|
| Recognition and diagnosis of symptoms and diseases (*n* = 1) | 0 | 0 | 1 (100) | 0 |
| Automation in health control (*n* = 1) | 0 | 0 | 1 (100) | 0 |
| Improved healthcare (*n* = 9) | 0 | 4 (44.4) | 2 (22.2) | 3 (33.3) |
| Regular surveillance of vulnerable groups and disease management (*n* = 5) | 0 | 2 (40) | 1 (20) | 2 (40) |
| Remote monitoring and alignment of health care (*n* = 1) | 0 | 0 | 0 | 1 (100) |
| Improved health and well-being (*n* = 1) | 0 | 1 (100) | 0 | 0 |
| Availability of Health Information (*n* = 2) | 0 | 1 (50) | 1 (50) | 0 |
| Prevention (*n* = 5) | 2 (40) | 1 (20) | 2 (40) | 0 |
| Prevention and tracking of infectious diseases (e.g., COVID) (*n* = 4) | 2 (50) | 1 (25) | 1 (25) | 0 |
| Prevention of risk behaviours and clinical complications (*n* = 1) | 0 | 0 | 1 (100) | 0 |
| Protection (*n* = 7) | 2 (28.6) | 2 (28.6) | 3 (42.9) | 0 |
| Protection of society and risk groups (*n* = 4) | 2 (50) | 1 (25) | 1 (25) | 0 |
| Data Protection (*n* = 3) | 0 | 1 (33.3) | 2 (66.7) | 0 |
| Usability (*n* = 1) | 1 (100) | 0 | 0 | 0 |
| Visually appealing (*n* = 0) | 0 | 0 | 0 | 0 |
| Ease of Use (*n* = 1) | 1 (100) | 0 | 0 | 0 |
| Total of Advantages (*n* = 39) | 8 (20.5) | 11 (28.2) | 11 (28.2) | 9 (23.1) |

*Note.* *N* = 267. C1 (Societal Benefits condition), *n* = 12; C2 (Privacy Assurance condition), *n* = 11; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 13; C4 (Informative condition), *n* = 11.

# Appendix G
# Table of the disadvantages depending on the participant's experimental condition

**Table 14**

*Disadvantages identified according to participant's experimental condition*

| | C1 | C2 | C3 | C4 | $X^2$ | *p* |
|---|---|---|---|---|---|---|
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) | | |
| No disadvantages (*n* = 37) | 7 (18.9) | 13 (35.1) | 4 (10.8) | 13 (35.1) | 6.57 | .087 |
| No opinion or non-perceptible response (*n* = 26) | 6 (23.1) | 7 (18.9) | 6 (23.1) | 7 (18.9) | .15 | .985 |
| Concerns about technology use (*n* = 76) | 20 (26.3) | 20 (26.3) | 19 (25) | 17 (22.4) | .32 | .957 |
| Concerns about privacy and protection of personal information (*n* = 61) | 17 (27.9) | 12 (19.7) | 16 (26.2) | 16 (26.2) | .97 | .809 |
| Contact Tracing (*n* = 10) | 3 (30) | 5 (50) | 1 (10) | 1 (10) | 4.4 | .221 |
| Concern about computer bugs or viruses in the app (*n* = 5) | 0 | 3 (60) | 2 (40) | 0 | .20 | .655 |
| Low usefulness (*n* = 45) | 9 (20) | 10 (22.2) | 19 (42.2) | 7 (15.5) | 7.53 | .057 |
| Effectiveness dependent on mass acceptance and commitment to monitoring (*n* = 16) | 2 (12.5) | 4 (25) | 7 (43.8) | 3 (18.8) | 3.5 | .321 |
| Existence of similar apps (*n* = 13) | 2 (15.4) | 2 (15.4) | 7 (53.8) | 2 (15.4) | 5.77 | .123 |
| Low reliability of the data collected (*n* = 9) | 1 (11.1) | 3 (33.3) | 3 (33.3) | 2 (22.2) | 1.22 | .748 |
| Potential exacerbation of COVID-19 concerns (*n* = 4) | 3 (75) | 0 | 1 (25) | 0 | 1 | .317 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Efficiency dependent on connectivity with other computer systems (*n* = 3) | 1 (33.3) | 1 (33.3) | 1 (33.3) | 0 | 0 | 1 |
| Not accessible to everyone (*n* = 37) | 8 (21.6) | 12 (32.4) | 7 (45.90) | 10 (27) | 1.6 | .661 |
| Difficulties in using the application (*n* = 21) | 4 (19) | 8 (38.1) | 4 (19) | 5 (23.8) | 2.05 | .563 |
| Need to own compatible smartphone (*n* = 9) | 3 (33.3) | 1 (11.1) | 2 (22.2) | 3 (33.3) | 1.22 | .748 |
| Potential segregation of the population (*n* = 6) | 1 (16.7) | 2 (33.3) | 1 (16.7) | 2 (33.3) | .67 | .881 |
| Mobile Application cost (*n* =1) | 0 | 1 (100) | 0 | 0 | - | - |
| Total of Disadvantages (*n* = 221) | 50 (22.6) | 62 (28.1) | 55 (24.9) | 54 (24.4) | 1.35 | .717 |

*Note.* *N* = 267. C1 (Societal Benefits condition), *n* = 62; C2 (Privacy Assurance condition), *n* = 69; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 65; C4 (Informative condition), *n* = 71.

# Appendix H
# Table of the disadvantages depending on the participant's COVID-19 Perceived risk and experimental condition

**Table 15**

*Disadvantages identified by participants with low COVID-19 Perceived Risk according to their experimental condition*

| | Low COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No disadvantages (*n* = 10) | 3 (30) | 2 (20) | 1 (10) | 4 (40) |
| No opinion or non-perceptible response (*n* = 5) | 1 (20) | 0 | 2 (40) | 2 (40) |
| Concerns about technology use (*n* = 15) | 3 (20) | 5 (33.3) | 5 (33.3) | 2 (13.3) |
| Concerns about privacy and protection of personal information (*n* = 12) | 3 (25) | 2 (16.7) | 5 (41.7) | 2 (16.7) |
| Contact Tracing (*n* = 2) | 0 | 2 (100) | 0 | 0 |
| Concern about computer bugs or viruses in the app (*n* = 1) | 0 | 1 (100) | 0 | 0 |
| Low usefulness (*n* = 14) | 3 (21.4) | 4 (28.6) | 5 (35.7) | 2 (14.2) |
| Effectiveness dependent on mass acceptance and commitment to monitoring (*n* = 3) | 1 (33.3) | 1 (33.3) | 1 (33.3) | 0 |
| Existence of similar apps (*n* = 5) | 0 | 2 (40) | 2 (40) | 1 (20) |
| Low reliability of the data collected (*n* = 4) | 1 (25) | 1 (25) | 1 (25) | 1 (25) |
| Potential exacerbation of COVID-19 concerns (*n* = 1) | 1 (100) | 0 | 0 | 0 |
| Efficiency dependent on connectivity with other computer systems (*n* = 1) | 0 | 0 | 1 (100) | 0 |
| Not accessible to everyone (*n* = 7) | 1 (14.3) | 4 (57.1) | 1 (14.3) | 1 (14.3) |
| Difficulties in using the application (*n* = 3) | 0 | 3 (100) | 0 | 0 |
| Need to own compatible smartphone (*n* = 3) | 1 (33.3) | 0 | 1 (33.3) | 1 (33.3) |
| Potential segregation of the population (*n* = 1) | 0 | 1 (100) | 0 | 0 |
| Mobile Application cost (*n* = 0) | 0 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Total of Disadvantages (*n* = 51) | 11 (21.6) | 15 (29.4) | 14 (27.4) | 11 (21.6) |

*Note*. *N* = 267. C1 (Societal Benefits condition), *n* = 10; C2 (Privacy Assurance condition), *n* = 12; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 13; C4 (Informative condition), *n* = 14.

**Table 16**

*Disadvantages identified by participants with medium COVID-19 Perceived Risk according to their experimental condition*

| | Medium COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No disadvantages (*n* = 21) | 2 (9.5) | 8 (38.1) | 3 (14.3) | 8 (38.1) |
| No opinion or non-perceptible response (*n* = 16) | 3 (18.8) | 6 (37.5) | 3 (18.8) | 4 (25) |
| Concerns about technology use (*n* = 47) | 16 (34) | 11 (23.4) | 7 (14.9) | 13 (27.7) |
| Concerns about privacy and protection of personal information (*n* = 38) | 13 (34.2) | 7 (18.4) | 6 (15.8) | 12 (31.6) |
| Contact Tracing (*n* = 8) | 3 (37.5) | 3 (37.5) | 1 (12.5) | 1 (12.5) |
| Concern about computer bugs or viruses in the app (*n* = 1) | 0 | 1 (100) | 0 | 0 |
| Low usefulness (*n* = 27) | 6 (22.2) | 5 (18.5) | 12 (44.4) | 4 (14.8) |
| Effectiveness dependent on mass acceptance and commitment to monitoring (*n* = 12) | 1 (8.3) | 3 (25) | 5 (41.7) | 3 (25) |
| Existence of similar apps (*n* = 6) | 2 (33.3) | 0 | 4 (66.7) | 0 |
| Low reliability of the data collected (*n* = 4) | 0 | 1 (25) | 2 (50) | 1 (25) |
| Potential exacerbation of COVID-19 concerns (*n* = 3) | 2 (66.7) | 0 | 1 (33.3) | 0 |
| Efficiency dependent on connectivity with other computer systems (*n* = 2) | 1 (50) | 1 (50) | 0 | 0 |
| Not accessible to everyone (*n* = 22) | 5 (22.7) | 7 (31.8) | 5 (22.7) | 5 (22.7) |

| | | | | |
|---|---|---|---|---|
| Difficulties in using the application (*n* = 12) | 3 (25) | 4 (33.3) | 3 (25) | 2 (16.7) |
| Need to own compatible smartphone (*n* = 5) | 2 (40) | 1 (20) | 1 (20) | 1 (20) |
| Potential segregation of the population (*n* = 4) | 0 | 1 (25) | 1 (25) | 2 (50) |
| Mobile Application cost (*n* = 1) | 0 | 1 (100) | 0 | 0 |
| Total of Disadvantages (*n* = 133) | 32 (24.8) | 37 (27.8) | 30 (22.6) | 34 (25.6) |

*Note.* *N* = 267. C1 (Societal Benefits condition), *n* = 40; C2 (Privacy Assurance condition), *n* = 46; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 38; C4 (Informative condition), *n* = 46.

**Table 17**

*Disadvantages identified by participants with high COVID-19 Perceived Risk according to their experimental condition*

| | High COVID-19 Perceived Risk | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| | *n* (%) | *n* (%) | *n* (%) | *n* (%) |
| No disadvantages (*n* = 6) | 2 (33.3) | 3 (50) | 0 | 1 (16.7) |
| No opinion or non-perceptible response (*n* = 5) | 2 (40) | 1 (20) | 1 (20) | 1 (20) |
| Concerns about technology use (*n* = 14) | 1 (7.1) | 4 (28.6) | 7 (50) | 2 (14.3) |
| Concerns about privacy and protection of personal information (*n* = 11) | 1 (9.1) | 3 (27.3) | 5 (45.5) | 2 (18.2) |
| Contact Tracing (*n* = 0) | 0 | 0 | 0 | 0 |
| Concern computer bugs or viruses in the app (n = 3) | 0 | 1 (33.3) | 2 (66.7) | 0 |
| Low usefulness (*n* = 4) | 0 | 1 (25) | 2 (50) | 1 (25) |
| Effectiveness dependent on mass acceptance and commitment to monitoring (*n* = 1) | 0 | 0 | 1 (100) | 0 |
| Existence of similar apps (*n* = 2) | 0 | 0 | 1 (50) | 1 (50) |
| Low reliability of the data collected (*n* = 1) | 0 | 1 (50) | 0 | 0 |
| Potential exacerbation of COVID-19 concerns (*n* = 0) | 0 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Efficiency dependent on connectivity with other computer systems (*n* = 0) | 0 | 0 | 0 | 0 |
| Not accessible to everyone (*n* = 8) | 2 (25) | 1 (12.5) | 1 (12.5) | 4 (50) |
| Difficulties in using the application (*n* = 6) | 1 (16.7) | 1 (16.7) | 1 (16.7) | 3 (50) |
| Need to own compatible smartphone (*n* = 1) | 0 | 0 | 0 | 1 (100) |
| Potential segregation of the population (*n* =1) | 1 (100) | 0 | 0 | 0 |
| Mobile Application cost (*n* = 0) | 0 | 0 | 0 | 0 |
| Total of Disadvantages (*n* = 37) | 7 (18.9) | 10 (27) | 11 (29.7) | 9 (24.3) |

*Note. N* = 267. C1 (Societal Benefits condition), *n* = 12; C2 (Privacy Assurance condition), *n* = 11; C3 (Societal Benefits *and* Privacy Assurance condition), *n* = 14; C4 (Informative condition), *n* = 11.